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The Canadian Entomologist

VOLUME XC

DECEMBER 1958

NUMBER 12

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PUBLISHED MONTHLY

by the Entomological Society of Canada and the Entomological Society of Ontario with the assistance of Le Ministère de l'Agriculture de la Province de Québec.

AUTHORIZED AS SECOND CLASS MAIL BY POST OFFICE DEPARTMENT, OTTAWA, pp. 91

The Canadian Entomologist

Editor: DR. EUGENE MUNROE, Room 335, Science Service Building, Carling Avenue, Ottawa.

Subscriptions

The subscription price is \$10.00 per year, payable in advance. This price includes postage but not currency or bank exchange, which must be calculated to yield the full subscription price in Ottawa. Subscribers receive the *Annual Report of the Entomological Society of Ontario*, through the courtesy of the Ontario Department of Agriculture and also the supplements to the *Canadian Entomologist*. Back numbers beginning with Volume 90 are available at \$1.00 per number and \$10.50 per volume, including postage; those prior to volume 90 are priced at 75c per number and \$6.50 per volume.

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The Canadian Entomologist

Vol. XC

Ottawa, Canada, December 1958

No. 12

Three New Ontario Black Flies of the Genus *Prosimulium* (Diptera: Simuliidae)

Part I. Descriptions, Morphological Comparisons with Related Species, and Distribution¹

By P. D. SYME² AND D. M. DAVIES³

INTRODUCTION

The Cytological Approach to Systematics

Chromosomal studies have elucidated phylogenetic relations in *Drosophila* (White, 1954), culicids (Jucci, 1952) and chironomids (Bauer, 1936, 1945). Since it appeared promising to apply this approach to the Simuliidae, Rothfels and Dunbar (1953) began a cytological survey of the black flies of eastern Canada during the summer of 1951. They found that in this group the giant salivary gland chromosomes provided "a wealth of descriptive morphological detail in their number and gross morphology, in the characteristics of expanded centromere regions, in the location of specific nucleolar sites, in the degree of pairing of constituents, and in the ultimate discernible banding pattern. . . . Since these features are not functionally related to the external environment, the confusing effects of convergence are minimized, resemblances may be taken to indicate relation, and grouping is possible according to natural affinities" (Rothfels and Dunbar, 1953).

The Taxonomic Situation of *Prosimulium hirtipes* (Fries)

European workers (Rubtsov, 1940, 1956; Grenier, 1947; Novak, 1956; L. Davies, 1957) have noticed and described the variation in *P. hirtipes* and in some instances have described new species or subspecies of the complex. In North America, Malloch (1914) noted variations in colour of adult *hirtipes* specimens, but found no significant differences between the North American and European adult specimens, although he mentioned that the pupal respiratory organ may have a total of 60 filaments in some specimens. These he lumped with the 16-filament type. Later workers (Dyar and Shannon, 1927; Twinn, 1936; Stone and Jamnback, 1955) also included the North American specimens under the name *P. hirtipes* (Fries).

It was not until recently that workers began to question seriously the validity of the name *hirtipes* in America. Rothfels (1956) in his cytological studies discovered that the segregate heretofore called *Prosimulium hirtipes* (Fries) in Ontario, is really a complex of species none of which are cytologically identical with any of the forms that have been called *Prosimulium hirtipes* from Northern Europe. He distinguished on cytological grounds three common species of the complex in southern Ontario, i.e., "*hirtipes* 1", "2" and "3". Chromosomal differences between "*hirtipes* 1" and "2" were indicated (Rothfels, 1956), and "*hirtipes* 3" is also readily diagnosed by its salivary gland chromosomes (Rothfels, 1956, pers. comm.). At least one other cytologically distinct species of the complex occurs sporadically in Ontario.

The discovery that certain simuliid species, including *Prosimulium hirtipes*, are really species complexes, has made necessary a revaluation of morphological

¹Contribution from the Department of Biology, McMaster University, Hamilton, Ontario, supported by grants from the National Research Council of Canada.

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and ecological characteristics. The purpose of this study was to discover morphological and ecological characteristics, which would allow the separation of those species inferred on cytological grounds, and to investigate their growth and activities.

METHODS

Collecting

From April 1 to August 8, 1956 and from April 3 to June 18, 1957, collections of larvae, pupae and adults of species in the "*hirtipes*" complex were made from various streams in Ontario. Samples of larvae from each stream were examined cytologically to determine whether one or more members of the "*hirtipes*" complex were present. The water temperature at each station was noted on each collecting day, as were the general features of the stream itself. Streams visited were those running off the Niagara escarpment near Hamilton, similar streams north of Toronto near Caledon, and one just south of Owen Sound. Others were those draining or emptying into Lake Sasajewun and Lake Opeonogo, Algonquin Park; the Kabshe River where it crosses Highway 11, south of Gravenhurst; streams near Uphill, Dalton Twp., Victoria Co. and various streams draining into the Ottawa River near Chalk River, Ontario.

Rearing

Pupae were sorted from the collections and reared by the method of Twinn (1936). Some mature larvae were reared in battery jars of distilled water with clean aquarium sand and some green moss (e.g., *Sphagnum* and *Fontinalis*), grass or reeds, and also a small amount of yeast or algae. Air was bubbled into these jars, which were cooled in running tap water. The formed pupae were allowed a few days to harden *in situ* before being transferred to emergence vials.

Preserving and Pinning

Larvae, pupae, exuviae and a few adults from each collection were preserved in alcohol and glycerine for later study.

Other freshly killed adults were affixed to an insect pin with shellac gel (Beirne, 1955), placed immediately into a glass container with a loose fitting lid and then put into a deep freezer at -18°C . They were left in this condition for at least a week, until they had dried out. Drying while frozen prevents specimens from collapsing and shrinking, and specimens treated in this way prove much superior to those dried at room temperature. This method was developed by Mr. D. M. Wood, who suggested its use early in 1956.

Preparation of Material for Cytological Study

Mature larvae intended for cytological work were fixed in the field by tearing the dorsum of the abdomen with fine forceps or dissecting needles to expose the salivary glands, after which specimens were placed in either of Carnoy's fixative (100% ethanol: glacial acetic acid, 3:1) or Newcomer's fixative (Newcomer, 1953). The fixed material was subsequently stained by the Feulgen reaction (Rothfels and Dunbar, 1953) or with aceto-orcein (Dunbar, 1958) and squashed to provide slides of the salivary gland chromosomes. The slides were made permanent with Euparal and species identification was carried out under an oil immersion objective.

Morphological Examination

Larvae, pupae and adults were examined whole under a dissecting microscope, and appendages were removed and mounted on slides for more detailed

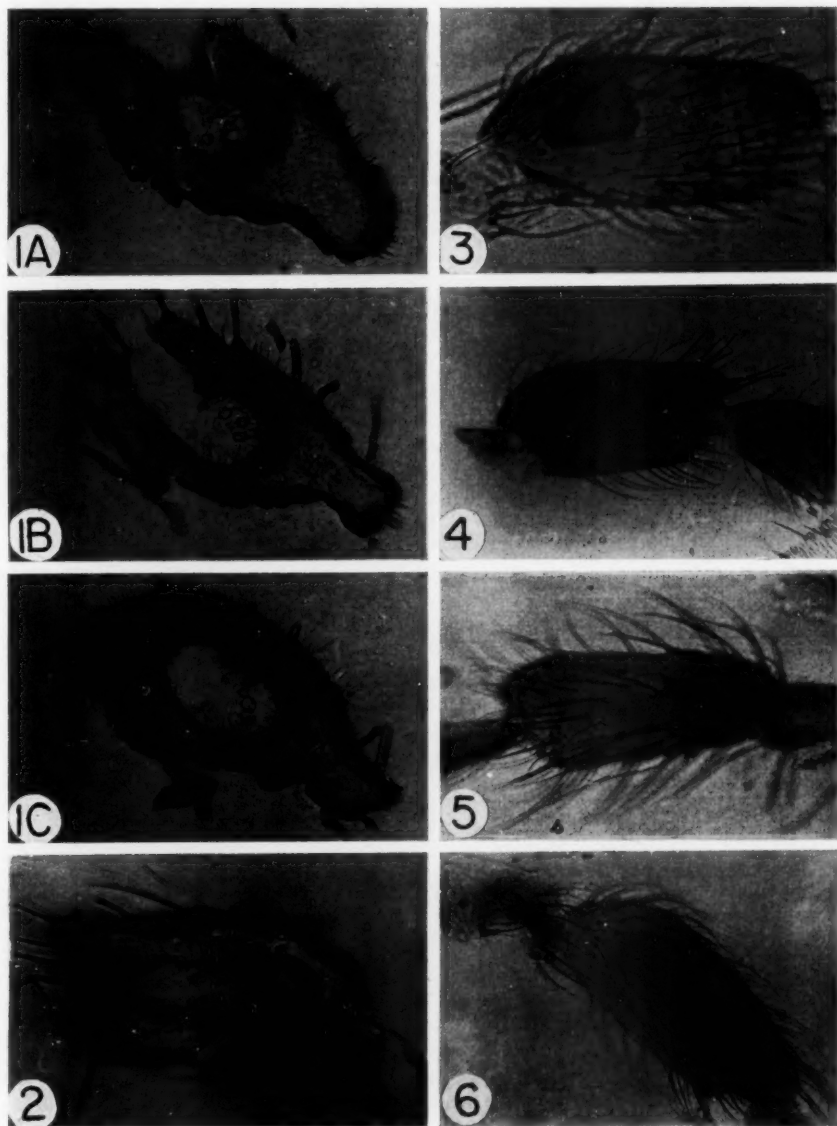


Fig. 1a, b, c. The central three of a set of serial longitudinal (9μ) sections of the third segment of the maxillary palp showing the structure of the female sensory vesicle of *P. fuscum*. Fig. 2. A longitudinal section (9μ) through the centre of the female sensory vesicle of *P. mixtum*. Figs. 3-6. Sensory vesicles in the third segment of maxillary palp of four *Prosimulium* species. Fig. 3. Female of *fuscum*. Fig. 4. Female of *mixtum*. Fig. 5. Male of *mixtum*. Fig. 6. Female of *travisi*.

examination and the making of camera lucida drawings. It was found that if the respiratory filaments of the pupae, or those dissected from the histoblasts of mature larvae, were placed in 50% acetic acid, or stronger, they tended to stretch and spread, simplifying the task of counting them. This procedure works best with fresh material and not so well with alcohol-hardened material.

Preparation of Sensory Vesicle for Study

To elucidate the structure of the sensory vesicle in the third segment of the maxillary palp of the three species, serial sections were made. Palps from dry-pinned and fresh adults were prepared for sectioning by Stile's modification of Mlle. Larbaud's method for the dehydration and infiltration of insect material (Gatenby and Beams, 1950). Longitudinal sections at nine μ , and transverse sections at 10 μ of the third maxillary palpal segment were cut on a rotary microtome, stained with Carbol-fuchsin stain (Beirne, 1955) and mounted in Euparal.

OBSERVATIONS AND RESULTS

The examination of many morphological characters of larvae, pupae, and adult males and females of the *hirtipes*-complex was required before keys to separate the three new species could be erected. One of the more important diagnostic features of the adults was the shape of the sensory vesicle.

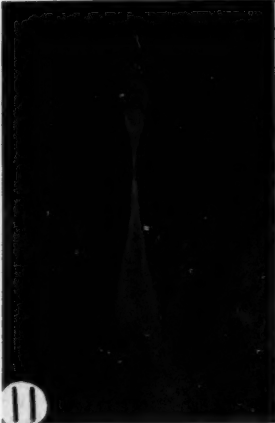
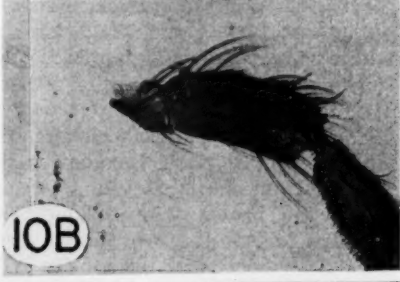
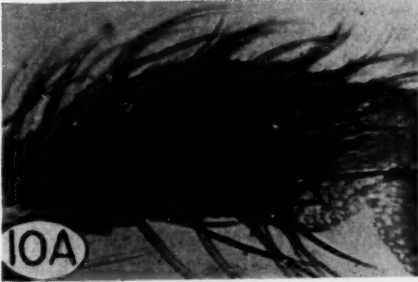
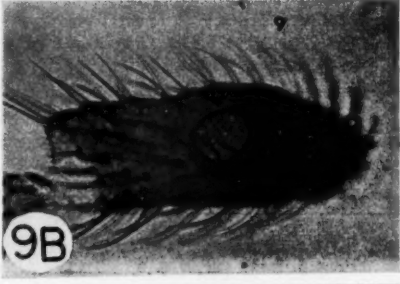
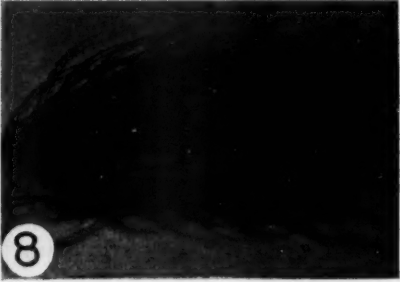
Sensory Vesicle of the Maxilla

Because the morphology of the sensory vesicle on the third palpal segment is difficult to interpret from the gross specimen and because the vesicle shape proved diagnostic, slides of serial sections were examined. From the sections of the vesicle of "*hirtipes* 1", "2", and "3" (= *Prosimulium fuscum*, *P. mixtum* and *P. fontanum*, respectively, the new species described in this paper) it was observed that it was a hollow ellipsoidal capsule within the third maxillary palpal segment. In both "*hirtipes* 1" and "2" the capsule was connected to the exterior at the anterior surface by means of a short tube (Figs. 1-5), while in "*hirtipes* 3" it opened directly to the exterior with no connecting tube, or a very short one (Figs. 7, 9 and 10). Also in "*hirtipes* 3" the vesicle was relatively larger and smoother than in "*hirtipes* 1" and "2" and had a consistently wider opening (Fig. 9).

The floor of the tube in "*hirtipes* 1" and "2" flattens exteriorly to merge almost imperceptibly with the outer surface of the segment, whereas the roof of the tube forms a well-defined lip at the surface, visible in the gross specimen (Figs. 3 and 4).

The interior of the vesicle in all three is covered with stiff hairs and so-called spatulate sensoria, the latter arising from pits in the wall of the vesicle (Figs. 2 and 20). These pits give rise to the rough or bumpy outer surface, as seen in the gross specimen. Nicholson (1945) reports that histological sections of *Cnephia dacotensis* (D. and S.) showed a large flask-shaped cell at the base of each of the spatulate sensillae (sensoria). He also mentions that Jobling (1928) described an apparently homologous organ in the palp of *Culicoides pulicaris* L., and was able to show that the sensillae are connected

Fig. 7. An oblique section through the sensory vesicle of a *P. fontanum* female. Fig. 8. Sensory vesicle in third maxillary palp of a *P. ursinum* female. Fig. 9a, b. Sensory vesicles of two *P. fontanum* females. Figs. 10. Sensory vesicles of two *P. fontanum* males (a. normal, b. abnormal). Figs. 11-13. Comparison of sclerotization of the ovipositor lobes in the three new *Prosimulium* species. Fig. 11. *fuscum*; Fig. 12. *mixtum*; Fig. 13. *fontanum*.



with the palpal nerve. In addition to discussing the sensory vesicle in Simuliidae and in *Culicoides*, Imms (1944) gives descriptions of this organ on the third segment of the maxillary palp of several other dipterous genera and families such as Blephariceridae (*Edwardsina*), Bibionidae, Anisopodidae, Mycetophilidae (*Asindulum*) and in the mecopterous family Nannochoristidae.

Descriptions of the New Species

Prosimulium fuscum sp. n.

Adult Female

Prosimulium fuscum, to the unaided eye, appears as a large, dark species. Body length 3.0-3.5 mm. Wing length 3.5-4.0 mm. Head black with appressed yellow pilosity. Frons at antennae 0.21 width of head, and at vertex about 0.37 width of head. Clypeus black with yellow hairs laterally and ventrally, thickest at the latero-ventral corners and pointing medio-ventrally. Occiput with a fringe of yellow hairs, with a few black ones posterior to the eyes. Antenna 11-segmented, tapering slightly from third segment; black with the first or first two basal segments brownish, mainly with pale yellow to white pilosity, larger hairs black. Maxillary palp black with black hairs. The third dilated palpal segment contains a sensory vesicle that is about 0.35 times as long as the segment and opens anteriorly to the exterior by means of a tube that arises near the distal end of the vesicle. The vesicle itself is situated at the proximal end of the segment (Fig. 3).

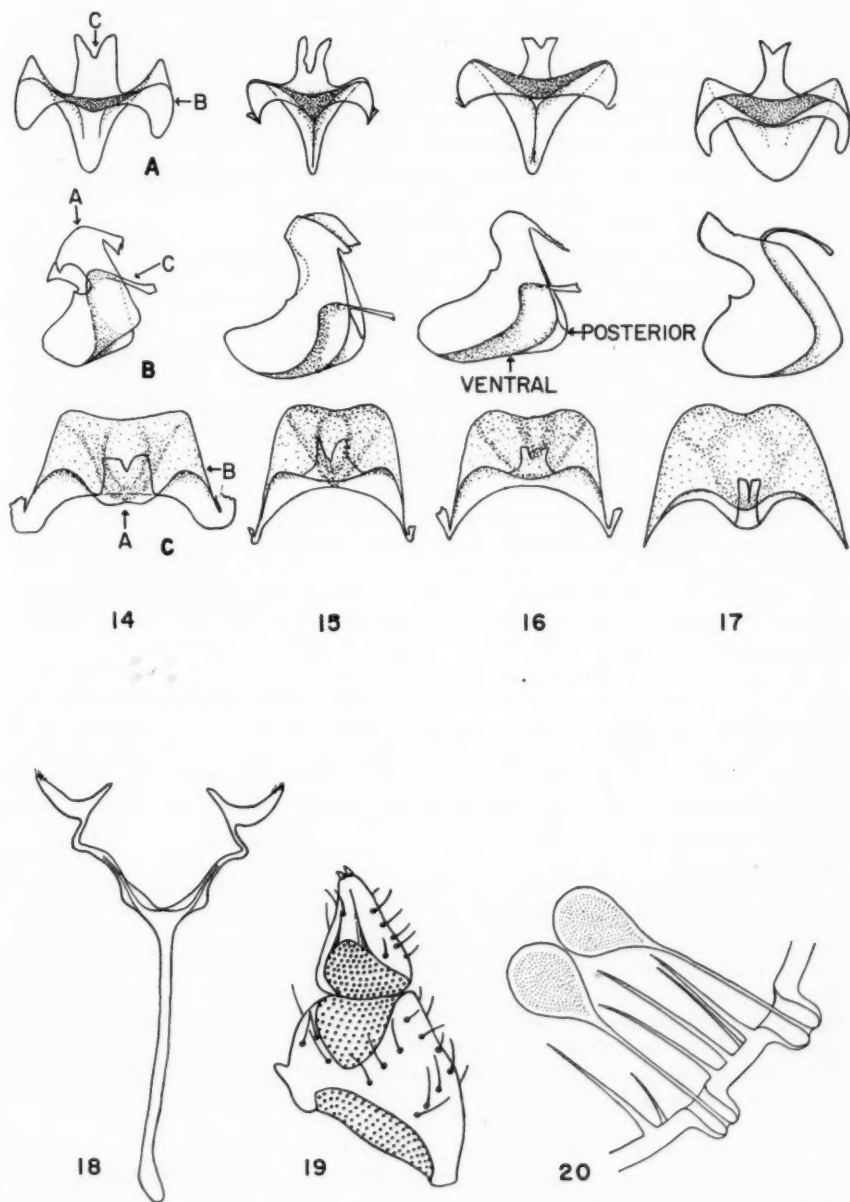
Thorax black with yellow pilosity. Pronotum sand-coloured to grey. Mesonotum uniformly black, except for humeral angles which are red-brown on anterior surface and which have a grey sheen on the black dorsal surface. Pile is short, yellow and appressed. Scutellum sand-coloured with erect yellow hairs and a few darker hairs. Postnotum black. Pleuron dark brown to black. Membrane light brown mottled with darker brown, occasionally sand-coloured. Metapleural tuft yellow. Haltere grey brown with yellow hairs. Hairs on most wing veins black, becoming yellower towards base of costa and subcosta, and those on the stem vein golden. Second basal cell present. Coxae and trochanters brown with yellow hairs. Femora and tibiae yellow to sand-coloured, except for their brown extremities. Hairs yellow, but brown portions of segments with black hairs. Tarsi grey to dark brown with black hairs. No pedisulcus or calcupala. Claws simple.

Abdomen with brown dorsal surface. Ventral surface grey near thorax, mottled with dark brown, and shading to solid dark brown towards genitalia. Pile pale yellow, but dark on genitalia. Basal fringe pale yellow. Cercus quadrate, a little more than 3.5 times as wide as long. Anal lobe reaching posterior edge of cercus. Ovipositor lobe reaching tip of anal lobe. The pattern of dark brown pigmentation along the medial margin of the ovipositor lobe is not sigmoid in shape and possesses more or less of a shoulder at the proximal end of the lobe (Fig. 11). Genital rod with little or no infilling at point of bifurcation. Arms ending in a triangular plate.

The name *fuscum* was applied to this species because of its general dark colouration (*fuscus* (Latin) = dark-coloured, dusky).

Adult Male

Body length 3.0 mm. Wing length 3.0-3.5 mm. Antenna 11-segmented, tapering gradually from third segment; all segments black with black hairs. Clypeus black with black erect hairs. Maxillary palp as in female except the vesicle is smaller in relation to the size of the third segment: 0.28 times the length of the segment in material from the type locality and as small as 0.22



Figs. 14-17. Three views of the male ventral plate in each of four *Prosimulium* species. Fig. 14. *fuscum*. Fig. 15. *mixtum*. Fig. 16. *fontanum*. Fig. 17. *ursinum*. Fig. 18. Genital rod of *P. fontanum* female. Fig. 19. Clasper of *P. fontanum* male. Fig. 20. Drawing of section of wall of sensory vesicle of *P. mixtum*.

times the length of the segment in material from some other localities. Vesicle opens to exterior by a connecting tube as in female. Occipital fringe black.

Pronotum and mesonotum black with pale yellow appressed pile. Scutellum dark brown with erect pale yellow hairs. Pleuron and membrane both dark brown; membrane sometimes mottled as in *P. mixtum* sp. n. and occasionally light as in *P. fontanum* sp. n. Pleural tuft pale yellow or black with pale yellow tips. Haltere black with black hairs. Wing with hairs black except those on base of costa, subcosta and stem vein, which may be yellowish. Subcosta with less than 50 hairs on it (Fig. 26). Legs all grey to black with black hairs and some yellow hairs on femora and tibiae.

Abdomen black with black sternites. Abdominal hair pale yellow becoming black towards genitalia. Basal fringe long and with black bases to the hairs, but the tips tend to grey or yellow. Coxite about as broad as long; style conical, about $\frac{2}{3}$ as long as coxite, incurved; the apex compressed and bearing two teeth or occasionally three. Sometimes one style bears three teeth while the other bears only two⁴. Ventral plate (Fig. 14) broad with a short, blunt and relatively thick ventral crest. As seen from the lateral view, the loop at the base of the median sclerite of the aedeagus usually extends farther dorsally than in *P. mixtum* sp. n. and *P. fontanum* sp. n.

Pupa

Length of body 4.5-5.5 mm.; of respiratory organ 2.0-2.5 mm. This organ consists of 16 filaments arising from three main trunks. The two ventral trunks each divide twice in a dichotomy to give rise to four filaments each. The median dorsal trunk divides into three branches near its base, the two outside ones dividing again to form three filaments each, and the median branch divides once to form two filaments. This is in perfect agreement with Puri's (1925) description of Norwegian *hirtipes* material. There is considerable variation as to the actual points of bifurcation in this organ, so that individual filaments sometimes appear to arise separately from one of the main trunks A, B or C (Fig. 25). All the 14-filamented individuals seem to arrive at this condition by the failure of (10 + 11) and (12 + 13) to branch⁴. Pupal chaetotaxy is illustrated in Fig. 24. Caudal hooks strong. Cocoon an irregular mass of silk covering most of the body.

Mature Larva

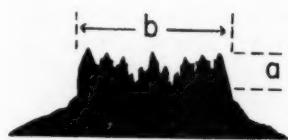
Average length of a mixture of 19 specimens from Lake Sasajewun Dam, Algonquin Park, and the Kahshe River was 7.8 (6.0-9.5) mm. A large, medium grey to grey-green species with a medium brown head capsule. The dorsal head pattern is not distinct from either *P. mixtum* or *P. fontanum*, nor is the occipital cleft of the head capsule. Outmost submental teeth higher than the remaining lateral teeth which become progressively shorter towards the median line, giving a "dished" appearance to the submentum. The median trifold tooth usually as high as the outmost teeth but not exceeding them (Fig. 21). Subapical ridge of the mandible with 12-20 forward-pointing teeth (Fig. 21).

Holotype, female: Kahshe River where it crosses Highway 11 south of Gravenhurst, Ontario. Pupa collected on April 27, 1956. Adult emerged on May 3, 1956. P. D. Syme.

Allotype, male: adult emerged on May 7, 1956. Otherwise, same data.

Paratypes, males and females, pinned, dissected and in alcohol, many pupal skins, a few pupae and some larvae, all collected on April 27, 1956.

⁴Davies (1949) discusses variability in this character in a population that he called *P. hirtipes* and that later proved to consist of *P. fuscum* and *P. mixtum*.



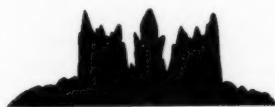
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22A



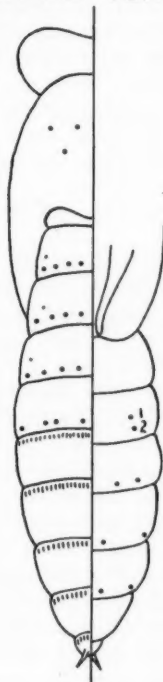
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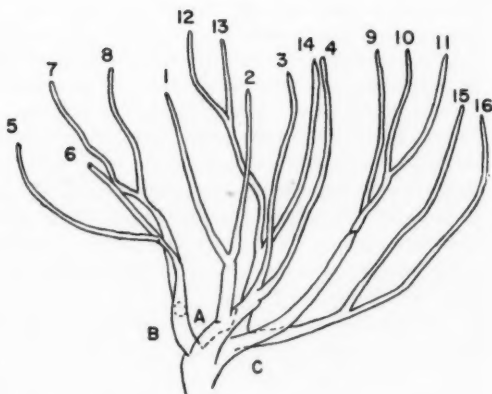
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DORSAL VENTRAL



24



25

Figs. 21-23. Larval submental teeth and subapical mandibular ridge of the three new *Prosimulium* species. Fig. 21. *fuscum*. Fig. 22a, b. *mixtum*. Fig. 23. *fontanum*. Fig. 24. Pupal chaetotaxy of *P. fuscum*. Fig. 25. Pupal respiratory organ of *P. fuscum*. A and B are ventral trunks; C is dorsal trunk.

Other Material: males and females, larvae and pupae from North Madawaska River just below Lake Sasajewun Dam, Algonquin Park, Ontario. Males and females from streams near Caledon, Caledon Twp., Peel Co., Ontario, April 1-8, 1956; males and females from Hopkins Creek at Dundas, Ontario, May 7, 1956 and May 1-7, 1957.

The type locality of this species is a large stream with a rather turbulent flow in April and May. It is about 25 ft. wide and has a rocky bottom where it emerges from under the highway bridge.

Prosimulium mixtum sp. n.

Adult Female

A medium-sized species. Of the three species described as new in this paper, *P. mixtum* is the smallest. Body length 2.5-3.0 mm.; wing length 3.0-3.5 mm. Head black with appressed golden pilosity. Frons at antennae about 0.2 width of head and at vertex about 0.4 width of head. Clypeus brown, covered sparsely with short yellow hairs medially, but more thickly and with longer hairs laterally and on the latero-ventral corners. These hairs converge ventrally towards the median line as they do in *P. fontanum*, but are not as coarse and black as in this species. Occiput with a fringe of yellow hairs with a few coarser, black ones arising posterior to the eyes. Antenna 11-segmented, tapering slightly from third segment and more abruptly from ninth, dark brown with yellow pile, but the coarser hairs are black in colour. Basal two segments slightly more yellow in colour, especially their distal edges, but not orange as in *P. fontanum*; one specimen in 18 had these segments orange. The two distal segments of the maxillary palp lighter brown than the third, dilated segment which contains the sensory vesicle. This vesicle is from 0.33 to 0.50 times the length of the segment, and opens on the anterior surface by means of a tube as in *P. fuscum* (Fig. 4).

Thorax mainly dark brown. Pronotum dark brown. Mesonotum uniformly dark brown except for humeral angles which are slightly lighter brown with a grey shade — hardly contrasting. Pile is short, golden and appressed on the central part of the dorsal surface, but longer on the lateral edges, and longer and erect posteriorly. The pile tends to curl rather than lie straight. Scutellum sand-coloured to brown with long, erect golden hair. Postnotum dark brown. Pleuron dark brown with a light and dark mottled brown to solid brown membrane. Metapleural tuft yellow. Haltere light brown with yellow hairs. Hairs on most wing veins black, becoming yellower towards base of costa and subcosta, and those on stem vein golden. Second basal cell present. Legs brown except for mid-portions of the femora and tibiae, which are more yellow-brown, especially on the ventral surface. The tarsi sometimes tend towards yellow. Hairs on the coxae, trochanters, femora and tibiae yellow; those on the tarsi brown. No pedisulcus or calcupala. Claws simple or rarely with a minute basal tooth.

Abdomen uniformly dark brown except for some grey shading on the first segment dorsally, and a grey area on the ventral surface towards the proximal end. The ventral shading is more or less mottled with dark brown. Pile light yellow, darkening to brown on the genitalia. Basal fringe yellow. Cercus quadrate, slightly less than three times as wide as long. Anal lobe reaching the posterior edge of the cercus. Ovipositor lobe almost reaching tip of anal lobe and generally smaller than that of *P. fuscum* (Fig. 12). The pattern of dark brown sclerotization along the medial margin of the ovipositor lobe is rather sigmoid in shape, tending sometimes to be diffuse towards the outer edge (Fig.

12). Genital rod not at all to only slightly infilled at the point of bifurcation, and with each arm ending in a triangular plate.

The Inglis Falls population near Owen Sound, Ontario, differs in having a larger (extends farther towards the distal end of the abdomen) and less mottled grey area on the ventral surface of the abdomen. The pleural membrane is often, though not always, lighter in colour yet still mottled with dark brown. The humeral angles of the mesonotum are often more shaded with grey, thus resembling *P. fontanum* in this respect. The hairs on the clypeus are somewhat coarser in this population but not as coarse as the corresponding hairs on *P. fontanum*. The Inglis Falls individuals also are more rotund than the typical specimens.

The name *mixtum* was applied to this species because of its similarity to *P. fuscum*, resulting in confusion in identification. Also the species is often found developing in the same stream with *P. fuscum* (*mixtus* (Latin) = intermingled, confused).

Adult Male

Body length 2.0-3.0 mm. Wing length 2.5-3.0 mm. Clypeus black with black, erect hairs. Antenna 11-segmented, tapering from third segment and more abruptly from ninth; all segments black with black hairs. Maxillary palp essentially as in the female, but more black than brown, and the size of the sensory vesicle in the third segment is smaller, 0.28 (0.26-0.33) times the length of the segment (Fig. 5). Occipital fringe black.

Pronotum dark brown. Mesonotum uniformly dark brown with light golden pile. Scutellum brown (to sand-coloured in the Inglis Falls population) with erect, golden hair. Pleuron dark brown with slightly lighter membrane, mottled as in female. Pleural tuft pale yellow. Haltere dark brown with dark hairs. Wing with all hairs black except those on the stem vein and squama, which are sometimes pale yellow to white. Subcosta with from 19-99 hairs depending on the population, but usually with more than 50 hairs (Fig. 26). Legs black to grey with black hairs except on the femora and tibiae, where they sometimes tend towards yellow.

Abdomen black, shading to grey on ventral surface with black sternites. Abdominal hairs yellow to black. Basal fringe long and black to grey. One specimen had yellow hairs on the abdomen, base of costa, and trochanters. Coxite about as broad as long; style conical, about $\frac{2}{3}$ as long as coxite, incurved, the apex compressed, and bearing two teeth or occasionally three (see footnote page 704). Ventral plate (Fig. 15) broad with a longer and thinner ventral crest than that in *P. fuscum*. The loop at the base of the median sclerite of the aedeagus usually not as pronounced dorsally as in *P. fuscum*.

Pupa

Length of body 3.0-4.0 mm.; of respiratory organ 2.0-2.5 mm. This organ consists of 16 filaments arising from three main trunks with the same branching pattern as in *P. fuscum*. Pupal chaetotaxy essentially the same as that of *P. fuscum* (Fig. 24). Caudal hooks strong. Cocoon weak and loose with no definite shape.

Mature larva

Average length of a mixture of 17 specimens from Inglis Falls and west of Uphill, Ontario was 6.6 (5.5-7.5) mm. By far the smallest of the three members of the "*birtipes*" complex treated in this paper. Body colour an even medium brown; colour of head capsule dark brown. Head pattern similar to

that of *P. fuscum*, as is the occipital cleft. All submental teeth usually of the same height (Fig. 22a), but sometimes the lateral teeth become progressively higher laterally, giving a "dished" appearance as in *P. fuscum* (Fig. 22b). The submentum shown in Fig. 22a is extreme and shows the greatest departure from the *P. fuscum* type. The median trifid tooth is usually of the same height as the two outermost teeth. The subapical ridge of the mandible resembles that of *P. fuscum* with 12-20 forward-pointing teeth (Fig. 22b).

Holotype, female: stream crossing 13th sideroad at Con. 6, Chinguacousy Twp., Peel Co., Ontario; 2 miles N.W. of Terra Cotta. Pupa collected on May 1, 1956. Adult emerged on May 6, 1956. P. D. Syme.

Allotype, male: adult emerged on May 4, 1956. Otherwise same data.

Paratypes, males and females, pinned, dissected and in alcohol, many pupal skins, a few pupae and some larvae, collected on May 1 and May 5, 1956. P. D. Syme and K. H. Rothfels.

Other Material: adults, pupae and larvae from about 3 miles west of Uphill, Dalton Twp., Victoria Co., Ontario, on Highway 503, May 12, 1956. Adults, larvae, exuviae and a few pupae from an inlet to the Sydenham River below Inglis Falls at the 6th Sideroad, Con. 6, Derby Twp., Grey Co., Ontario (Inglis Falls inlet), 1000 yd. S.W. of Harrison Park, just south of Owen Sound, Ontario, June 23, 1956. Males and females from Hopkin's Creek, where it crosses the York Road near Dundas, Ontario, May 7, 1956 and May 1-7, 1957.

The type locality of this species is a wide and extremely shallow stream with a slow velocity, its rocky bed covered with moss and water cress (*Nasturtium*).

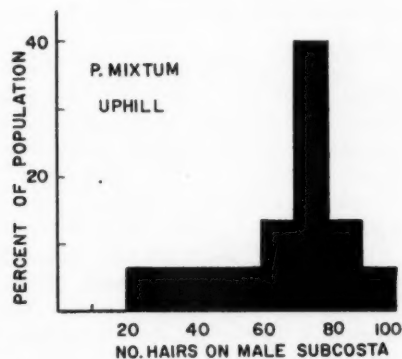
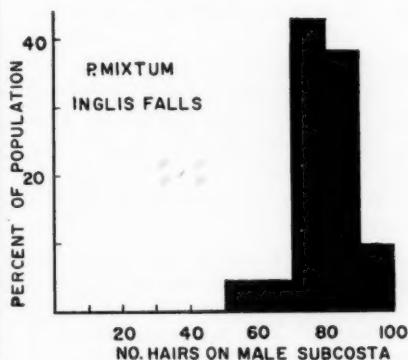
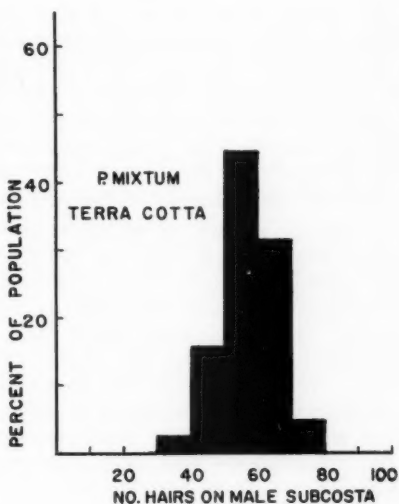
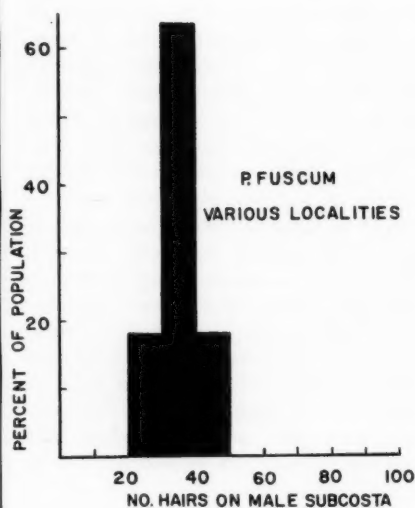
Prosimulium fontanum sp. n.

Adult Female

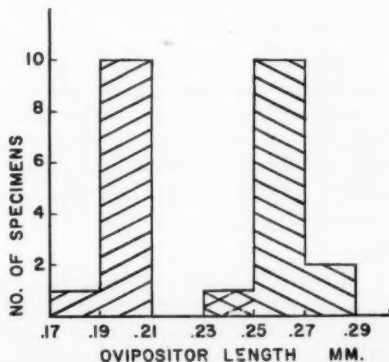
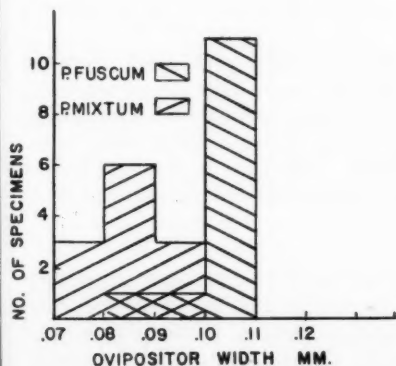
Prosimulium fontanum to the unaided eye appears as a large yellow-orange species. Body length 2.5-3.5 mm. Wing length 3.0-3.2 mm. Head black with appressed golden pilosity. Frons at antennae about 0.25 times width of head, and at vertex about 0.38 times width of head. Clypeus brown with short yellow hairs dorsally and medially, and longer black hairs arising from the latero-ventral corners, their tips curving ventro-posteriorly and converging towards the median line. Occipital fringe golden. Antenna 11-segmented, tapering slightly from third segment and more abruptly from ninth; dark brown with black hairs except basal two segments which are orange-brown with black hairs. The first three segments of the maxillary palp are dark brown with black hairs; the distal two segments lighter brown with black hairs. Third palpal segment possessing a sensory vesicle about 0.38 times as long as the segment, and opening anteriorly to the exterior directly by means of a wide mouth, with little or no connecting tube (Fig. 9).

Thorax mostly dark brown. Pronotum light grey-brown. Mesonotum uniformly dark brown except for anterior margin and humeral angles which are usually light grey-brown and contrasting. Pile is short, golden and appressed on the dorsal surface, becoming slightly matted posteriorly, and longer on the humeral angles and laterally. Scutellum light sand-coloured with long, erect, golden pile mixed with a few darker hairs. Postnotum dark brown. Pleuron dark brown with a light sand-coloured membrane, occasionally darken-

Fig. 26. Histograms of the number of hairs on the male subcosta of *P. fuscum* and *P. mixtum* from various localities. Fig. 27. Histograms of the frequency of various lengths and widths of ovipositor lobes of *P. fuscum* and *P. mixtum*.



26



27

ed. Pleural tuft golden. Haltere yellowish sand-coloured with golden hairs. Hairs on most wing veins black, becoming yellower towards base of the costa and subcosta, and those on the stem vein golden. Second basal cell present. Coxae and trochanters brown and sand-coloured with golden hairs. Femora sand-coloured to yellow with yellow hairs, as are the tibiae except for their distal ends which are brown with darker hairs. Tarsi dark brown to grey with black hairs and occasionally with some yellow hairs on the basitarsi. No pedisulcus or calcipala. Claws simple.

Dorsal surface of abdomen brown, shading into lighter brown on the sides, and into grey on the ventral surface. Pile golden, darkening towards the genitalia. Basal fringe long and golden. First abdominal segment grey dorsally, occasionally dark brown, and with light grey anterior and posterior edges. Cercus quadrate, about three times as wide as long. Anal lobe reaching the posterior edge of cercus. Ovipositor lobe almost reaching tip of anal lobe. The pattern of dark brown sclerotization along the medial margin of the ovipositor lobe is similar in shape to that of *P. mixtum* (Fig. 13). Genital rod partially infilled at point of bifurcation, and with each arm ending in a triangular plate. The infilling at the point of bifurcation is not always as extreme as indicated in Fig. 18.

The name *fontanum* is applied to this species because the larvae are often found in small, spring-fed streams (fontanus (Latin) = pertaining to a spring).

Adult Male

Body length 2.5-3.5 mm. Wing length 2.5-3.0 mm. Clypeus black with black, erect hairs. Antenna 11-segmented, tapering gradually from third segment; all segments black with black hairs. Maxillary palp essentially as in female, except the sensory vesicle in the third segment tends to be smaller (0.25 times the length of the segment) with a smaller opening (Fig. 10a), and this vesicle occasionally possesses a neck connecting it to the exterior rather than opening directly (Fig. 10b). Occipital fringe black.

Pronotum dark brown. Mesonotum dark brown except for lighter anterior margin as in the female. This margin is browner and not as grey as in the female. Pile darker golden, slightly longer and sparser on the mesonotum than it is in the female. Scutellum sand-coloured. Pleuron essentially as in the female with a darker membrane. Pleural tuft of golden hairs with a few black; rarely entirely black. Haltere black with black hairs. Wing with all hairs black. Legs all grey to black with black hairs, except on ventral surface of fore-coxae, sometimes the mid-coxae, and all the femora, on which the hairs are yellow.

Abdomen black dorsally shading to grey ventrally with black sternites. Abdominal hair black. Basal fringe long and black. Coxite about as broad as long; style conical, about $\frac{2}{3}$ as long as coxite, incurved, the apex compressed and bearing two teeth on all specimens seen (Fig. 19). Ventral plate broad with a long thin ventral crest as in *P. mixtum*. The loop at the base of the median sclerite of the aedeagus usually not as pronounced dorsally as in *P. fuscum* (Fig. 16).

Pupa

Length of body 3.5-4.0 mm.; of respiratory organ 2.0-2.5 mm. This organ consists of 16 filaments arising from three main trunks with the same branching pattern as in *P. fuscum* and *P. mixtum*. Pupal chaetotaxy is the same as that of *P. fuscum* (Fig. 24). Caudal hooks strong. Cocoon very weak, consisting of only a few threads.

Mature Larva

Average length of a mixture of 12 specimens from the first Tote Road stream at Lake Sasajewun and Smith's Lake inlet, Algonquin Park, was 7.0 (6.0-7.5) mm. A large light brown species with a medium brown head capsule. Dorsal head pattern similar to that in *P. fuscum* and *P. mixtum*. Occipital cleft as in *P. fuscum*. Outermost submental teeth enlarged, higher than the remaining two lateral teeth which are usually of equal height. The median trifid tooth usually as high as, or higher than, the outermost lateral teeth (Fig. 23). Subapical ridge of mandible with 12-20 upright teeth (Fig. 23).

Holotype, female: first small stream on the Tote Road on the east side of Lake Sasajewun, a mile from the Wildlife Research Station, Algonquin Park, Ontario. Pupa collected on June 22, 1956. Adult emerged on June 26, 1956. P. D. Syme and D. M. Davies.

Allotype, male: pupa collected on June 20, 1956, and adult emerged on June 29, 1956. Otherwise same data.

Paratypes, males and females, pinned, dissected and in alcohol, many pupal skins, a few pupae and larvae, all collected June 20 and 22, 1956.

Other Material: males and females from second stream on the Tote Road 1/2 mile north of the type locality. Males and females, larvae and exuviae from streams entering Ottawa River near Chalk River, Ontario (at North Star Lodge, and crossing Laurentian Point Road). Males and females, larvae and pupae from stream opposite Bates' Island on west shore of south arm of L. Opeongo 1 1/2 miles from Ontario Fisheries Research Laboratory, Algonquin Park, Ontario. Males and females from a bog-fed stream on the north shore of Sproule Bay, L. Opeongo, opposite Ontario Fisheries Research Laboratory. Males and females from Smith's Lake inlet in Algonquin Park.

The type locality of this species is a small bog-fed stream, which is reduced to a trickle in June, but still remains cool. The pupae were found usually embedded in the moss that covered the rocks in the stream.

**Keys to *P. fuscum*, *P. mixtum* and *P. fontanum*
from Eastern North America**

Adult Females

- A Ovipositor lobe with the median sclerotization pattern expanding laterally into a shoulder at the proximal end of the lobe (Fig. 11). Sensory vesicle in the third segment of the maxillary palp with a tube connecting it to the exterior (Fig. 3). Emerges in the early spring. *P. fuscum*
- A Ovipositor lobe with the sclerotization pattern sigmoid in shape and no shoulder at the proximal end of the lobe (Figs. 12 and 13). Sensory vesicle with or without a tube connecting it to the exterior. Emergence from early spring to mid summer. B
- B Sensory vesicle with a tube connecting it to the exterior (Fig. 4). Basal two segments of the antennae only slightly lighter in colour than remaining segments. Humeral angles of thorax not usually contrasting. Pleural membrane light brown mottled with dark brown, to solid dark brown. Abdomen dark brown and thoracic pilosity yellow. Emerges from early spring on. *P. mixtum*
- B Sensory vesicle with little or no tube connecting it to the exterior; external opening wider in either case (Fig. 9). Basal two segments of antennae orange-brown and contrasting. Humeral angles of thorax lighter and usually contrasting. Pleural membrane usually sand-coloured. Abdomen brown to light brown. Thoracic pilosity golden. Emerging from late May to August. *P. fontanum*

Adult Males

- A Sensory vesicle usually without a tube connecting it to the exterior (Fig. 10a). Pleural membrane usually sand-coloured. Ventral plate with thin ventral crest (Fig. 16). *P. fontanum*
- A Sensory vesicle with a tube connecting it to the exterior. Pleural membrane light brown to dark brown. Ventral plate with either a thick or thin ventral crest. B

- B Ventral plate with a short thick ventral crest (Fig. 14). Hairs on subcosta usually less than 50. *P. fuscum*
 B Ventral plate with a longer thin ventral crest (Fig. 15). Hairs on subcosta usually more than 50. *P. mixtum*

Mature Larvae

- A The two innermost lateral teeth of submentum distinctly lower than the outermost tooth, and of equal height (Fig. 23). Subapical ridge of mandible with upright teeth (Fig. 23). A large light brown species with medium brown head capsule *P. fontanum*
 A The three lateral teeth of equal height or grading down from the outermost tooth. Subapical ridge of mandible with forward-pointing teeth. B
 B The three lateral submental teeth often of equal height (Fig. 22a); occasionally grading down from the outermost tooth. A small brown species with dark brown head capsule. *P. mixtum*
 B The three lateral submental teeth always grading down from the outermost tooth (Fig. 21). A large grey species with light brown head capsule. *P. fuscum*

Comparison of Diagnostic Characters and Their Variations

It seems worth while to summarize the points of distinction of the three Ontario members of the *hirtipes* complex and to mention others that were not brought out in the description.

Of the three species, *P. fontanum* is the most distinct in both the larval and adult stages. Thus, the toothing of both the larval mandibles (Fig. 23) and the submentum (Fig. 23) is characteristic. The colour and size of *fontanum* larvae also aid in distinguishing them. The adult females of *fontanum* being large and tawny, and possessing a darker golden pilosity, light humeral angles, sand-coloured pleural membranes and orange basal segments of the antennae, stand out from the females of the other two species. The shape of the sensory vesicle in the maxillary palp is the most definitive diagnostic character in both sexes of *fontanum*. This vesicle was as indicated in Figs. 9 and 10a in more than 20 specimens of each sex, but in one male specimen it was flask-shaped (Fig. 10b). A few *P. mixtum* specimens also possessed flask-shaped vesicles rather than the usual type. Aside from the vesicle, the only other diagnostic character in male *fontanum* specimens is the light pleural membrane. Even this was occasionally dark in both sexes.

The remaining two species, *mixtum* and *fuscum*, are much more similar in all stages. As larvae, *fuscum* is generally larger and greyer with a lighter brown head capsule than *mixtum*. The submental teeth, although differing in shape, vary enough to make this means of identification unreliable in many cases. Thus the submental teeth in *fuscum* are generally wider and lower, and in all specimens seen, have a "dished" appearance whereas *mixtum* tends to have these teeth higher and of an even height. The ratio of the height of the median trifid tooth (distance "a" in Fig. 21) to the width at the base of the submental teeth (distance "b" in Fig. 21) was calculated, but the difference was slight. For twelve specimens each the average ratio arrived at was 0.249 (0.209 - 0.287) for *fuscum* and 0.281 (0.219 - 0.333) for *mixtum*. Also the primary filaments of the mouth fan are a little longer in proportion to the stalk length in *fuscum* than in *mixtum*. In *fuscum* this ratio averaged 2.64 (2.43 - 2.86) for 17 specimens and in *mixtum* it averaged 2.44 (2.04 - 2.72) for 35 specimens. No differences were found in the proportions of the larval antennae and maxillae or in the dentation of the mandibles.

The adults of these two species are even more similar than the larvae. Of the two, females of *fuscum* have a paler yellow pilosity on the thorax and a generally darker body, but females of both have a darker body and a more lightly coloured pilosity than *fontanum*. There is a more pronounced reddish

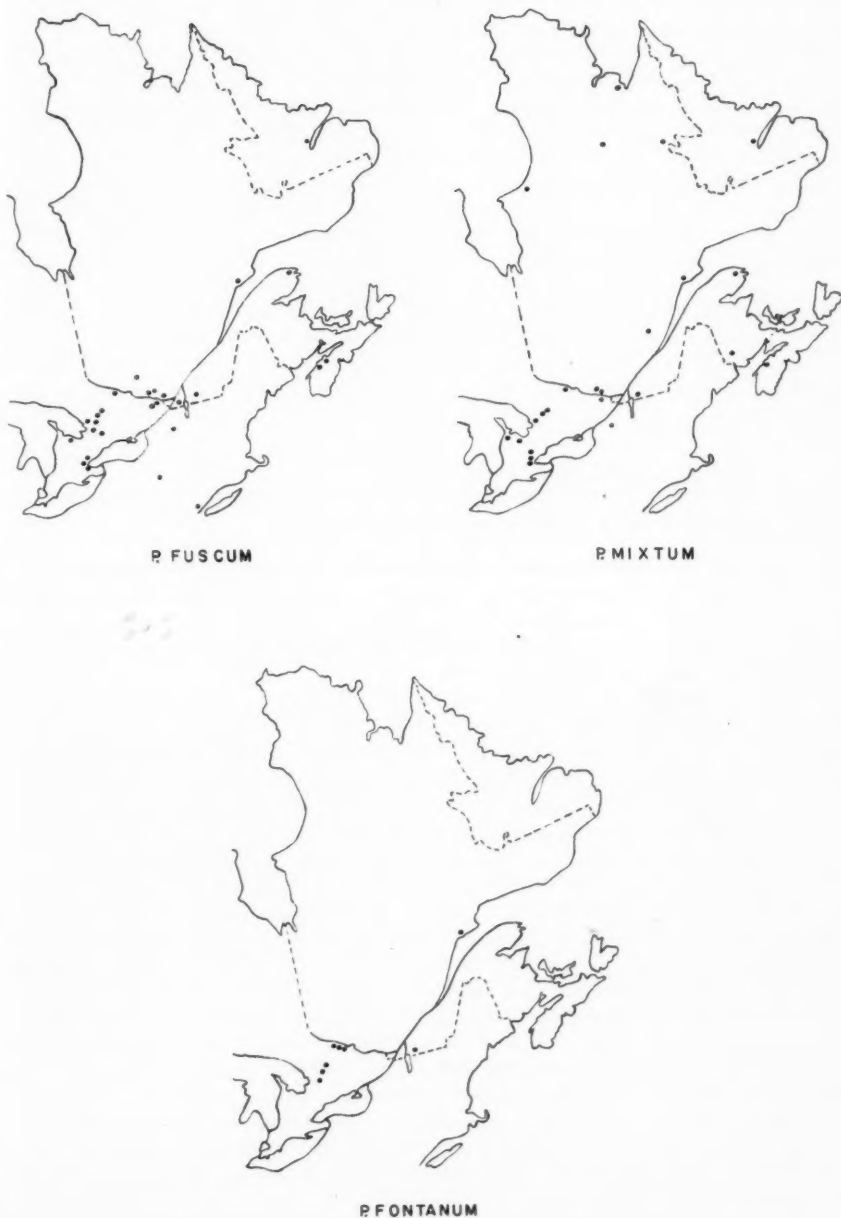


Fig. 28. Three maps showing the distribution of *P. fuscum*, *P. mixtum* and *P. fontanum*, respectively, in northeastern North America.

shade on the anterior surface of the humeral angles of the thorax in *fuscum* than on that in *mixtum*. The antennae of *fuscum* females were found to be slightly longer than those of *mixtum* females. The average length of the female antenna in nine specimens examined was 0.73 (0.68 - 0.80) mm. for *fuscum* and 0.55 (0.45 - 0.68) mm. for *mixtum*. Also the ratio of the third antennal segment to the tenth was less for *fuscum* females, averaging 1.42 (1.29 - 1.67) as compared to 1.81 (1.50 - 2.00) for *mixtum*. A slight difference was noticed also in the dimensions of the L-shaped anal lobe. The average length of the postero-ventral arm of the anal lobe in six specimens of each species was 0.16 (0.14 - 0.17) mm. for *fuscum* and 0.13 (0.12 - 0.14) mm. for *mixtum*. There was no usable difference in the length of the dorsal arm of the anal lobe because, although measurements of the dorsal arm averaged longer in *fuscum*, those in *mixtum* fell entirely within the range of variation for *fuscum*. There is a difference in the size of the ovipositor lobes, those of *fuscum* being longer and wider (Fig. 27). However, the only reliable diagnostic character found was the shape of the sclerotization pattern on the ovipositor lobes as indicated in Figs. 11 and 12.

In the males of *fuscum* and *mixtum* the number of hairs on the subcosta provides a diagnostic character that is useful in most cases (Fig. 26), while the ventral plate of the male genitalia is stouter and has a thicker, shorter ventral crest in *fuscum* as compared to the same organ in *mixtum* (Figs. 14 and 15).

No difference could be found between the pupae of *mixtum* and *fontanum*, but the respiratory filaments of *fuscum* are shorter in proportion to the length of the pupal body than those of *mixtum* or *fontanum*.

The New Species Compared with Related Members of the Complex

The three new species of the "*birtipes*" complex in Ontario having been described, it seems worthwhile to compare them with their closest allies in both North America and Europe, and to point out distinguishing features that have come to the notice of the writers.

The larval individuals in the National Collection at Ottawa, collected in June and September, 1949, near Whitehorse, Yukon Territory, and previously identified as *P. birtipes*, were found in 1957 to most resemble *P. fontanum* in the form of the submental teeth. Also, the drawing of the submental teeth of the Alaskan *birtipes* by Sommerman (1953) shows a similar resemblance. However, 16 collections of larvae from Anchorage, Alaska sent recently to Dr. Rothfels by Dr. Sommerman contained specimens that were cytologically "*birtipes* 2". These specimens along with another sample of larvae and adults sent to the writers by Dr. Sommerman from Fort Richardson, Alaska, were examined and found to possess the *fontanum* type of submental teeth but not to resemble either *fontanum* or *mixtum* in colour, being slightly more mottled. Of the three lateral teeth on each side of the submentum, the middle one in the Alaskan specimens is slightly shorter than the medial one, accentuating the contrast between the outermost tall lateral tooth and the others. The two more medial teeth were of equal height in the *fontanum* specimens examined. The adult Alaskan specimens examined are close to *mixtum* in that the sensory vesicle has a tube connecting it with the exterior in both sexes and the pronotum is dark brown in the females. The females differ, however, in having a light pleural membrane and a relatively light abdomen as does *fontanum*. The males have a thick ventral plate similar to *P. urisum* (Edw.) (Fig. 17).

It is possible that the Alaskan population is a geographic race of *P. mixtum* having constant morphological differences that separate it from the eastern population, or that it is a new species in its own right.

Prosimulium hirtipes (Fries), as defined by L. Davies (1957) and which is most likely the true *hirtipes*, is in the female at least, according to the specimens examined by us from Alston, Cumberland, England (coll. April 18, 1954, by L. Davies), a large grey, dark-legged species looking superficially most like *P. fuscum*, but differing from it in the pattern of sclerotization of the ovipositor lobes (Fig. 11), in which it most resembles *P. mixtum* (Fig. 12). The colour of this sclerotization is distinctly grey in *hirtipes*, whereas in *mixtum* and *fontanum* it is brown, and in *fuscum* it possesses at least a brown shade. The sensory vesicle in the third segment of the maxillary palp is essentially as in *fuscum* and *mixtum*, i.e., it possesses a collar, but again it is grey in colour, whereas the same organ in the three North American species is brown.

P. inflatum Davies (1957) differs from all our species in the presence of yellow hairs on most of the wing veins, the shape of the clypeus, which is inflated, and the greater infilling at the point of bifurcation of the genital rod. In the larva, the submental teeth resemble those of *fontanum* (Fig. 23), but the outermost teeth are even larger in *inflatum*. Also, in the larva, the mandibular phragma of *inflatum* extends ventrally farther than in any of our species, resembling that in *P. ursinum* (Edw.). The entire head capsule of mature *inflatum* larvae is jet black to dark brown, whereas in the Ontario complex that of *mixtum* is by far the darkest but is never black.

Rubtzov (1956) established three varieties of *P. hirtipes* (Fries) in U.S.S.R. Drawings by Rubtzov (1956) show that the first, *P. hirtipes hirtipes* (Fries), differs from the three Ontario species of the *hirtipes*-complex in the larval submental and subapical mandibular teeth, in the shape of the female sensory vesicle (Lauterborn's organ) and in the shape and pattern of sclerotization of the ovipositor lobes. Also its size, especially in the larval stage, exceeds the average size of the three Ontario species, being closest to *fuscum*. Females of *P. hirtipes luganicum* Rubtz. differ from all our species in being as large as *fuscum* but possessing dull golden pilosity on the thorax rather like *P. mixtum* or *fontanum*. The thorax is greyish-black, resembling *fuscum* in this respect, but the halteres are yellow. The ovipositor lobes are smaller than those of *fuscum* and possess a pattern of sclerotization similar to that of *mixtum*. Females of *P. h. diminutum* Rubtz. compare in size with those of *mixtum* and *fontanum* but the colour of the integument is black and the pilosity is silvery. The genital rod, according to Rubtzov's figure, differs from our three species in the shape of the end plate. The larval submental teeth of *P. h. diminutum* most resemble those of *fuscum* (Fig. 21), but are more extreme in their "dished" appearance. The female of *P. tridentatum* Rubtz. (Rubtzov, 1956) differs from that of *P. fontanum* in the colour of the antennae which are all black. It differs from our three species in that the maxilla has only three strong teeth on each side. The larvae differ from our species in the shape of the submental teeth which are of the *P. fuscum* type (Fig. 21), but more markedly "dished".

The North American *P. rhizophorum* Stone and Jamnback (1955) differs from all our species in the form of the pupal respiratory filaments, which can also be seen and recognized in mature larvae. Three pupae of *rhizophorum* from Brooktondale, N.Y., (coll. April 24, 1954) differed from *P. fuscum*, *mixtum* and *fontanum* also in the absence or great reduction of spines 1 and 2 on the ventral surface (Fig. 24).

P. saltus Stone and Jamnback (1955) differs in larvae, pupae, and adult males and females from the three species herein described. Thus the larval submental teeth resemble those of *fontanum*, but the outermost teeth are from only slightly

to considerably larger than the others and the next tooth is the smallest of the three, similar to that in the Alaskan *mixtum*. This condition held in six specimens examined from Cayutaville, N.Y. (coll. April 13, 1957). The subapical ridge of the mandibles had only six and nine teeth on the paratype specimen examined. The pupal respiratory filaments differ in being smoother than they are in our three species, while the main trunks are slightly dilated distally. Pupal chaetotaxy was also different. The clasper of the adult male paratype from Schuyler Co., N.Y., (coll. April 24, 1954) was truncate rather than conical, with two teeth. The sensory vesicle of the male was necked, whereas that of the female paratype from Cayuta Lake, N.Y., (coll. May 17, 1950) was not. The ovipositor lobe had a pattern of sclerotization similar to that of *fontanum*, but with a small shoulder. The sclerotization did not extend more than about halfway down the medial edge of the lobe.

Alaskan specimens of *P. ursinum* (Edwards), a 14-filamented species, were also examined. The claspers of the male possess two teeth, as described by Stone (1952), but the ventral plate is much stouter (Fig. 17) than that of *P. fuscum*. The sensory vesicle in the maxillary palp is also much smaller than those of the new species, at least in the female. It is about 0.25 times the length of the segment in the male (Stone, 1952) and about 0.29 times the length of the segment in the female, and possesses a wide opening somewhat similar to that in *P. fontanum* (Fig. 8). The ovipositor lobes are similar to those of *P. mixtum*, but the pigmentation is more diffuse. Also the anal lobes are as in Twinn's (1936) drawing (under the name *P. browni* Twinn, a synonym), and this certainly distinguishes it from any of *fontanum*, *fuscum* or *mixtum*. The pupal chaetotaxy is the same as in *fuscum*, *mixtum* and *fontanum*. The respiratory filaments exhibit the same type of branching as those in the latter three species (Fig. 25), except that usually (10 + 11) and (12 + 13) fail to branch, giving 14 filaments. This is the same condition that exists in *P. fuscum* individuals that have only 14 filaments. In three *ursinum* specimens examined, one had 16 filaments and the others had 14. In the larva, the mandibular phragma extends almost to the mentum, and the pigmented pattern on the head is as pictured by Sommerman (1953). The median submental tooth is not always small, as described by Sommerman (1953), however.

Examination of pupal paratype material of *P. travisi* Stone disclosed that the respiratory filaments exhibit essentially the same branching as in *fontanum*, *fuscum* and *mixtum*. However, the stalks seem to be shorter, and therefore the filaments longer. Pupal chaetotaxy shows no significant differences. Larval submental teeth are similar to those of *fontanum*. In an adult female dissected from a pupa, the ovipositor lobes are short with a pattern of sclerotization similar to that in *mixtum*. The sensory vesicle (Fig. 6) resembles that in *fuscum* and *mixtum*. *P. travisi* females from Stone's description differ from all our species in having the head and first two antennal segments orange brown, the postnotum reddish brown and the abdomen yellowish brown with pale yellow hairs. The anal lobes of the dissected specimen are short and barely exceed the base of the stubby, rounded cercus.

The *hirtipes* females reported from Minnesota (Nicholson and Mickel, 1950) appear from the description to be either *P. fuscum* or *P. mixtum*, but closer to the former.

Johannsen (1903) described a species from New York, which he called *hirtipes* and which conforms in the adult stage closely to *P. fuscum* and possibly to *P. mixtum*. However, if his association of the larvae and pupae with

adults is valid, the shape of the larval submental teeth, the pupal chaetotaxy and the branching pattern of the pupal respiratory filaments indicate that it is none of the species herein described.

Distribution of the Three New *Prosimulium* Species

P. fuscum, *P. mixtum* and *P. fontanum* all occur in Central Ontario and Southern Quebec (Fig. 28). From here *fuscum* and *mixtum* extend farther north and east to Labrador and the Maritime Provinces, west to the Bruce Peninsula and south into New York State, and possibly into Minnesota. *P. mixtum* extends even farther north in the north-east to Fort Chimo, Quebec, and what corresponds to *mixtum* cytologically (i.e., "hirtipes 2" of Rothfels, 1956) occurs in Alaska in the north-west (Rothfels, 1957, pers. comm.).

P. fontanum, according to present knowledge, is fairly well restricted to the granite portions of Ontario and Quebec, mainly the Precambian Shield, except for two collections at Knowlton, Quebec, about 55 miles E.S.E. of Montreal, from artificial drainage ditches along the roadside.

Yet another species of the *hirtipes* complex was discovered by Dr. Rothfels in larvae collected by D. M. Davies and D. M. Wood on April 21, 1957, in streams crossing Highway 17 east of North Bay (in Sharpes creek, just west of Rutherglen and in Amable du Fond river, three miles northeast of Eau Claire, Nipissing District, Ontario).

Of the three newly described species, *mixtum* appears to be the most widely distributed and the most common.

Lack of material west of Georgian Bay, Ontario, is possibly because of insufficient collecting in this area, since the known distribution of the species centres around the areas of active black-fly research, namely the Toronto-Hamilton, Algonquin Park and Ottawa districts.

DISCUSSION

Earlier descriptions of *P. hirtipes* from North America (Malloch, 1914; Dyar and Shannon, 1927; Nicholson and Mickel, 1950; Stone and Jamnback, 1955; Twinn, 1936; D. Davies, 1949) indicated a considerable variation in the morphology and colouration of this species, as summarized by L. Davies (1957). It can be seen that much of this variation is caused by "*Prosimulium hirtipes*" in North America being in reality a complex of very closely related species. Another reason for the discrepancies between descriptions is that even species other than members of the complex may have been included. Malloch (1914) mentioned that the pupal respiratory organ of *hirtipes* may have 60 branches and his illustration of the submental teeth correspond to those of *P. magnum* D. and S., a species not unlike *hirtipes* (s.l.) in the adult stage. Of course, a third reason for the discrepancies between descriptions is that the species do vary in colour and morphology.

Of the three species described in this paper, *P. mixtum* appears to vary the most. This species exhibits considerable variation in number of hairs on the male subcosta, in colour of the pleural membrane and of the abdominal integument, in the size of the body as indicated mostly by the fatness rather than length, and in the larval submental teeth. The Inglis Falls population near Owen Sound, Ontario, was strikingly different from all other *P. mixtum* examined and corresponded to *P. fontanum* in characters such as size, general body colouration and colour of the pleural membrane. This was so marked that it was felt that this population may prove to be a new sibling. It is, however, cytologically a "*hirtipes* 2" (= *P. mixtum*) type (Rothfels, 1956, pers. comm.),

and corresponds to *mixtum* in the pattern of sclerotization in the ovipositor lobes and in the shape of the sensory vesicle in the maxillary palp. Although differences do exist, it was felt that the evidence was insufficient to separate it from *P. mixtum* at this time.

It must be remembered here that the three species, *P. fuscum*, *P. mixtum* and *P. fontanum*, were not erected as species initially on morphological grounds, but on cytological evidence and on indirect evidence of their inability to interbreed. That is, the cytological studies presented strong evidence that these species did not interbreed, or at least that if they did the resulting zygotes were inviable. Actually "*hirtipes* 2" (= *P. mixtum*) varies cytologically more than the other two species (Rothfels, 1956, pers. comm.) and further work is needed to establish the full limits of this species. The other two species, *P. fuscum* and *P. fontanum*, appear to be more stable in morphological characteristics.

SUMMARY

Cytological studies have shown that the segregate heretofore called *Prosimulium hirtipes* (Fries) in Ontario is really a complex of species, none of which are cytologically identical with the *Prosimulium hirtipes* from northern Europe.

Full morphological descriptions of three of these species are given and the structure of the sensory vesicle in the third segment of the maxillary palp of the adult is described in detail, a feature of diagnostic value. Keys to the adults and larvae are presented.

The morphological characters used in describing the species are compared and their variability and usefulness discussed. The three new species are compared also with closely related species in North America and Europe.

The known distribution of the three new species is given.

ACKNOWLEDGEMENTS

We wish to express thanks to Mr. G. E. Shewell, Division of Entomology, Ottawa, for his suggestions and generosity in making available simuliid specimens in the Canadian National Collection; to Dr. Alan Stone, U.S. National Museum, Washington, D.C., and Dr. K. M. Sommerman, Arctic Health Research Centre, Anchorage, Alaska, for their ready cooperation in supplying specimens; to Dr. K. H. Rothfels, University of Toronto, for supplying specimens and the locality of simuliid breeding sites, for helpful suggestions and for critically reading the manuscript. We are grateful also to the Ontario Department of Lands and Forests for their kindness in making available services at two of their research stations in Algonquin Park and to Mrs. O. Anderson for translating pertinent literature in the Russian Language.

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(Received May 29, 1958)

Mortality of the European Red Mite (Acarina: Tetranychidae) from Secretion of Peach Leaf Nectaries¹

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Every spring since it was first noticed in 1947, the first-generation immature stages of the European red mite, *Metatetranychus ulmi* (Koch), has suffered some mortality in peach orchards of the Niagara Peninsula of Ontario. Sometimes this mortality was negligible but in the cold, wet spring of 1949 it reached 80 per cent in some orchards. Mortality of similar extent has not been noticed on other hosts of the mite at this season; counts of a thousand or more living and dead mites on young shoots of each host at Vineland Station on May 16, 1957, showed apparent mortalities of 53 per cent on Elberta peach, 7 per cent on Italian prune, and 8 per cent on Melba apple. The mortality on peach leaves is difficult to determine, for if the mites are examined too early, many of those killed in the quiescent, premoulting condition cannot be distinguished from living ones, and if they are examined too late, the survivors may have suffered mortality from other causes.

The higher mortality of the mites on peach was evidently caused by the nectar secreted by the extrafloral nectaries on the edges of the leaf blade near the petiole. Leaves of Italian prune, in common with other *Prunus* species, also bear nectaries but they secrete much less nectar than those of peach. Apple leaves lack nectaries. According to Knapheisowna (1927) the secretion of peach leaf nectaries contains sugars and tannins. Observations at Vineland Station showed that the nectaries start secreting when the leaves are about two-thirds to three-quarters grown, and gradually cease after the leaves are fully expanded. The mite larvae hatching from overwintered eggs congregate on the under sides of the small leaves at the bases of the shoots, which are the only ones expanded at that time, often at the bases of the leaves near the nectaries. When the leaves remain wet for long periods after a rain, the nectar may diffuse over a considerable part of the base of the leaf and kill the mites. Its presence, coextensive with that of dead mites, is often indicated by dust adhering to the sticky residue, unless later rains have removed it.

To test the above hypothesis, 50 mites of various stages were covered individually with small drops of water into which the nectar from two to four nectaries was introduced by means of a micropipette. The drops were then allowed to evaporate in the laboratory. All the mites were dead 24 hours later, never having moved from their original positions.

Also, lots of 20 mites each were covered individually with small drops of 0.5, 1, 2.5, 5, and 10 per cent solutions of sucrose, which were allowed to evaporate. Concentrations of 2.5 per cent or higher caused 100 per cent mortality; one mite survived at the 1 per cent and 6 at the 0.5 per cent concentrations after 24 hours. A number of control lots suffered not more than 5 per cent mortality.

The viscosity and presumably the sugar content of the nectar varied greatly so that the concentrations of its solutions cannot be compared directly with those of the sucrose solutions. Also, the volume of the drops of both the nectar and sucrose solutions varied considerably owing to the difficulty of wetting the leaf surface and the mites. The critical factor with both solutions is apparently the thickness of the sticky film formed on drying. Mortality from the nectar is probably due to the mechanical effect of this film, for honey bees, ants, flies,

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and other insects feed freely on the nectar in the orchards and adults of the coccinellid *Stethorus punctillum* Weise survived for long periods in the laboratory when fed it exclusively (Putman, 1955).

Mortality of the later generations of the mite from this source is negligible for they are almost entirely confined to mature leaves with nearly or quite functionless nectaries.

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(Received April 24, 1958)

Influence of Humidity on Mortality and Rate of Development of Immature Stages of the Grain-Infesting Mite *Tyrophagus castellanii* (Hirst) (Acarina: Acaridae) Reared on Mould Cultures¹

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It was observed that populations of *Tyrophagus castellanii* (Hirst) reared on cereal flakes and yeast for studies of predator-prey interactions were feeding on moulds rather than on the food material, and that an increase in humidity increased their rates of development. To discover whether this was caused by the direct effect of humidity on the mites, or by a greater supply of fresh food brought about by an increase in humidity, rearings were made with a technique developed by Rivard (1958). The mites were reared exclusively on mould cultures under controlled temperature and humidity conditions. It was also possible with this technique to regulate mould growth to some extent, so that a supply of fresh food was always available to the mites. This is a report on the influence of various humidities on mortality and rate of development of the immature stages of *T. castellanii* at a constant temperature.

Materials and Methods

All specimens used were from a stock culture of mites bred on a mould, *Aspergillus* sp., for several generations and were reared individually in cells. These cells were placed inside desiccator jars in which different constant relative humidities were maintained by various solutions of potassium hydroxide (Peterson, 1949). Rearing was done in a cabinet at a constant temperature of $77 \pm 1^\circ\text{F}$. Series of tests were made at relative humidities of 60, 70, 80, 90, and 100 per cent. Twenty replicates of 10 eggs each were incubated individually in every test except at 60 per cent relative humidity, for which only five replicates were made. All eggs within a replicate at a given humidity were usually from a single female specimen of *T. castellanii* maintained at the same humidity. However, the daily egg-production at 70 per cent relative humidity was sometimes insufficient, so that eggs from two females had to be used. Moreover, as the females kept at 60 per cent relative humidity did not oviposit, the eggs in-

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TABLE I
Percentage mortalities of *T. castellanii* during developmental stages
at 77° F. and various humidities

Relative humidity %	No. eggs incubated	Egg %	Larva %	Protonymph %	Deutonymph %	Total %
60	50	100	—	—	—	100
70	200	38	12	8	0	58
80	200	37	4	9	0	50
90	200	33	7	9	0	49
100	200	44	13	11	1	69
Difference necessary for significance at 5% level		10	6	6	—	10

cubated at that humidity were obtained from mites reared at 70 per cent relative humidity. The material was examined daily and the development was recorded. As there was usually plenty of food in the cages, the mites were reared in the same containers and left undisturbed throughout their development, but to facilitate observations at the higher humidities it was sometimes necessary to open the cages and remove part of the mycelium when mould growth became too abundant.

Results and Discussion

Mortality

As shown in Table I, total mortality observed during the incubation period was remarkably high at each of the humidities used. None of the eggs submitted to a relative humidity of 60 per cent hatched and most of them dried out in a few days, indicating that this point is probably just below the lower limit of relative humidity for survival. Melville (1957) found that this limit was about 65 per cent relative humidity at 25°C. for a related species, *Tyrophagus entomophagus* (Lab.). At 70, 80, and 90 per cent relative humidity approximately equal percentages of eggs did not hatch, whereas mortality reached 44 per cent at 100 per cent relative humidity. In the last instance mould developing directly on the eggs may have killed a number of them. At any rate, except for the series of tests at 60 and 100 per cent relative humidity, there appeared to be little difference between the various humidities in the percentages of eggs that failed to hatch. However, the heavy mortality during the incubation period throughout the experiment suggests that, though the mites can develop and reproduce when fed with mould only, this diet is deficient in some respect and prevents them from laying a high percentage of viable eggs.

Table I also shows that the mortality among the larvae varied from four per cent at 80 per cent relative humidity to 13 per cent at 100 per cent. On the other hand, about the same number of mites died in the protonymphal stage at each humidity whereas all deutonymphs, except one at 100 per cent relative humidity, completed their development. Total mortality was lowest at 80 and 90 per cent relative humidity but nearly half the individuals died before reaching the adult stage. As the greatest differences in the mortality rates occurred either during the egg stage, when the influence of food was nil, or

TABLE II
Average durations in days of the developmental stages of *T. castellanii*
at 77° F. and various humidities

Relative humidity %	Sex	No. observed	Egg		Larva*		Proto-nymph*		Deuto-nymph*		Total	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
70	Male	38	5-8	6.1	3-7	4.5	2-7	3.5	2-9	4.0	14-25	18.1
	Female	47	5-8	6.1	3-7	4.5	2-7	4.0	2-14	4.9	14-31	19.5
	Total	85	5-8	6.1	3-7	4.5	2-7	3.8	2-14	4.5	14-31	18.9
80	Male	52	4-7	5.4	2-4	3.1	1-6	2.5	1-6	2.5	11-19	13.5
	Female	49	5-7	5.5	2-6	3.1	1-6	2.6	2-9	3.1	11-22	14.3
	Total	101	4-7	5.5	2-6	3.1	1-6	2.5	1-9	2.8	11-22	13.9
90	Male	46	4-7	5.5	2-3	2.5	1-3	1.8	1-3	2.1	10-14	11.9
	Female	56	5-7	5.4	2-4	2.6	1-5	2.1	1-5	2.3	11-20	12.4
	Total	102	4-7	5.5	2-4	2.5	1-5	2.0	1-5	2.2	10-20	12.2
100	Male	25	4-7	5.3	2-3	2.6	1-5	2.2	1-4	2.3	10-18	12.4
	Female	38	4-7	5.4	2-6	2.7	1-4	2.0	1-6	2.6	10-21	12.7
	Total	63	4-7	5.3	2-6	2.7	1-5	2.1	1-6	2.5	10-21	12.6

*Including the quiescent period before moulting.

during the larval stage, when the supply of fresh mould was always abundant, the variation was probably due to the effect of humidity on the mites themselves.

Rates of Development

The average durations of the different stages in the development of the mites as determined from data on the individuals that reached the adult stage are given in Table II. In the range 80-100 per cent relative humidity, the mean length of the incubation period was not significantly affected by a change in relative humidity, but at 70 per cent the incubation was retarded by an average of about 12 hours ($P < 0.01$). Durations of the larval and nymphal stages were significantly shorter ($P < 0.01$) at 90 per cent relative humidity than at 80 per cent, and a further decrease of ten per cent in humidity again increased the length of development. These stages were also slightly longer at 100 per cent relative humidity than at 90 per cent though only the deutonymphs showed a significant difference. Durations of the larval and nymphal stages together averaged 12.8, 8.4, 6.7, and 7.3 days at 70, 80, 90, and 100 per cent relative humidity respectively. The quiescent phase preceding each molt lasted for from a few hours to more than two days but had a tendency to be shorter at the higher humidities. The average total length of time required to reach the adult stage varied from 12.2 days at 90 per cent relative humidity to 18.9 days at 70 per cent relative humidity. Statistical analysis of the data with the *t* test (Cox, 1954) showed that the means obtained at 70, 80 and 90 per cent relative humidity were significantly different ($P < 0.01$), but that an increase of humidity above 90 per cent did not influence the speed of development of the mites. As the mites were observed to feed on both the mycelium and the spores of the mould and as there was always a

sufficient fresh supply of both of these foods in the cages maintained at a relative humidity of 80 per cent or higher, the differences then observed would appear to be a direct effect of humidity on the mites. However, mould growth was much slower at 70 per cent relative humidity, especially towards the end of the rearing period. Because of the drier conditions the food was less palatable and probably retarded development.

The number of days required for development varied widely and the range was greatest at the lower humidities. Table II shows that the range was always greater for the females than for the males; the latter developed slightly faster on the average, though the differences observed were significant ($P < 0.01$) only for the mites reared at 70 per cent relative humidity. The sex ratio of 351 mites was about 54 per cent females; this is close to the ratio observed by Davis (1944) for a related species, *Tyrophagus lintneri* (Osborn), which was 58 per cent females.

Summary

When a grain-infesting mite, *Tyrophagus castellanii* (Hirst), was reared on a mould culture, *Aspergillus* sp., at 77°F., no eggs hatched at 60 per cent relative humidity, and mortality during the incubation period was close to 40 per cent at 70, 80, 90, and 100 per cent. Mortality during the larval stage was about five per cent at 80 and 90 per cent relative humidity and reached 12 per cent at 70 and 100 per cent, whereas almost 10 per cent of the mites died in the protonymphal stage at each humidity and all deutonymphs completed their development. Total mortality was 50 per cent at 80 and 90 per cent relative humidity and almost 60 and 70 per cent at 70 and 100 per cent relative humidity respectively. The incubation period lasted 5.5 days in the range 80 to 100 per cent relative humidity but was half a day longer at 70 per cent. Durations of the larval and nymphal stages together averaged 12.8, 8.4, 6.7 and 7.3 days at 70, 80, 90, and 100 per cent relative humidity respectively. The total length of time required to reach the adult stage varied from 12 days at 90 per cent relative humidity to 19 days at 70 per cent, with the males always developing slightly faster than the females. About 54 per cent of the mites reared were females.

Acknowledgments

The author acknowledges the helpful criticisms and advice of Dr. T. Burnett of the Belleville laboratory.

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(Received May 13, 1958)

Two New Species of *Euryomma* (Stein) (Muscidae: Diptera) from Panama¹

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In studies of army ants on Barro Colorado Island, Canal Zone, Panama, C. W. Rettenmeyer collected two new species of *Euryomma* in association with colonies of *Eciton burchelli* (Westw.). Adults of both species were collected flying above refuse heaps of the ants, a good series of one was reared, and all stages of the larvae of both were taken in berlese samples of the refuse deposits. Descriptions of all stages of both species, except for the egg and puparium of the rarer species, are presented here. No immature stages of *Euryomma* spp. have been known previously, nor are there any published data on the life-history and habits of any species of the genus.

Six species of *Euryomma* have been described previously. Five are known from South America and one is cosmopolitan. There are no previous records of *Euryomma* spp. from Panama. The two species described here are distinguished from all other species of the genus except *E. nigrifemur* Stein (which was described from Chile) by the very dark brown femora and from that species by the brown (rather than yellow) tibiae. Additional characters that separate them from other species of the genus are the distinctly pubescent arista, the general dark colouration, and the very long dorsal bristles on the hind tibiae.

Holotypes and allotypes are in the Snow Entomological Museum, University of Kansas, Lawrence, Kansas. Paratypes are in the above museum, the United States National Museum, the Canadian National Collection, the American Museum of Natural History, and the California Academy of Sciences.

Euryomma rettenmeyeri n.sp.

Figs. 1-3, 7, 9-16, 21.

This species can be easily recognized by the clear yellow basal antennal segments and the basally yellowish palpi and, in the male, by the absence of a hind tibial anteroventral bristle.

Male

Length 4.0-4.5 mm.

Head.—Parafrontals one-third as broad as long, yellowish-brown pollinose, separated by a reddish-brown pollinose frontal vitta slightly broader than either parafrontal. Parafrontal setulae sparse, uniserial. Parafacial with a few setulae on the upper half. Occipital bristles short, strong, regular. Postoccipital bristles absent. First two antennal segments yellow; third segment black, twice as long as broad; arista yellow on basal fifth, black apically, pubescent (hairs two to three times as long as basal arisal diameter). Palpus basally yellowish, the yellow extending along dorsal margin to apical fourth, otherwise black; theca slender, weakly sclerotized, pollinose.

Thorax.—Pale yellowish-brown pollinose, with a broad, distinct median vitta and two diffuse lateral (supraalar) vittae medium brown; scutellum pale yellowish-brown, with two subbasal dark-brown spots. Acrostichals irregularly triserial, tending to be quadriserial postsuturally. Accessory setulae moderate in strength and number. Prealars two, the second bristle weaker than and situated above and slightly behind the first. Scutellum with only the subbasal

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and preapical pairs of marginals strong, with a pair of weak marginal bristles, and about three pairs of setulae basally and a stronger pair of bristles preapically on the disc. Propleuron bare. One strong and one very weak stig-matal setula. Mesopleuron with setulae very sparse, not stronger dorsally. Sternopleuron with no distinct median bristle. Squamae with the lower slightly longer, pale yellowish, margins concolorous. Halteres pale yellow. Wings clear, veins brown.

Abdomen.—1.2 by 1.5 mm. Dark brownish-grey pollinose, laterally with pale-grey anterior margins, grey pollen expanding laterad to cover anterior half of each segment at margin; dorsocentral vitta diffuse, dark. Hypopygium weakly projecting.

Legs.—Dark brown, except knees and tibial bases yellowish. Fore femur posteroventrally with setulae on basal half and two strong and two weak bristles on distal half. Fore tibia with a median anterodorsal bristle. Mid femoral anteroventrals short (less than half as long as femoral diameter), weak, becoming shorter and closer-set apically to form a weak comb; posteroventrals similar, becoming stronger apicad, weakly duplicated ventrally on median third. Mid tibia only slightly thicker apicad, with a short, weak multiserial ventral mat of hairs; one anterodorsal, one posterodorsal, the latter distinctly stronger. Hind coxa with a single strong bristle-hair posteroventrally. Hind femoral anteroventrals setulose except for two strong preapical bristles; posteroventrals setulose. Hind tibia with no anteroventral, one anterodorsal, two strong dorsals, the preapical 0.6, the median 0.8 mm. long.

Hypopygium (Figs. 1-3).—Cercal plate elongate, slender. Surstylus not fused with ninth tergum, broad basally with a rounded dorsal expansion medially; ventral and mid-dorsal margins bearing several bristlelike hairs. Ninth sternum broad, interrupted medially, basal flange broad, directed outwards; postgonites reduced to tiny stubs; aedeagus of equal breadth throughout, weakly curved dorsally. Fifth sternum divided transversely by a membranous band except at lateral margin, with three strong and several weak bristles on the basal portion; lateral process short and thick, bearing four or five small bristles; apical margin distinctly sclerotized, bearing numerous weak bristles.

Female

Head and Thorax.—As in the male.

Abdomen.—Colour as in the male, except that the dorsocentral vitta is scarcely apparent.

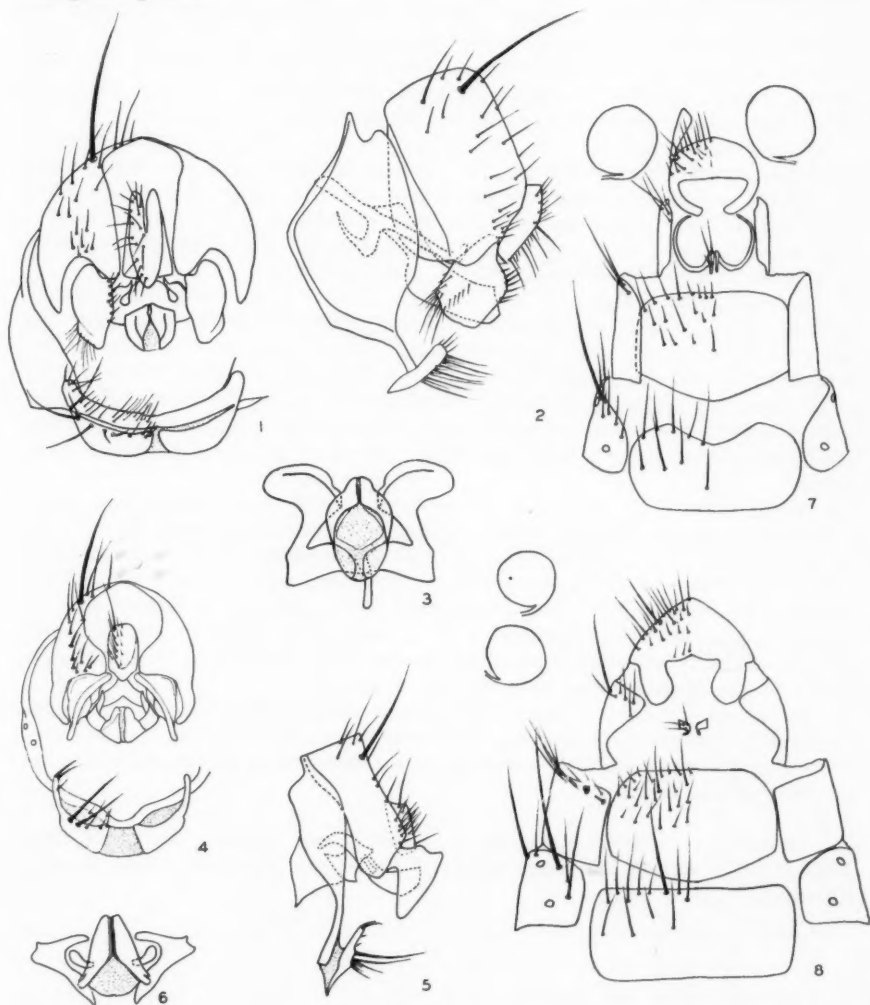
Legs.—As in the male except as follows: Mid femoral anteroventrals and posteroventrals setulose apically, basally with five or six short but distinct bristles on each surface; hind tibia with a distinct strong anteroventral, dorsal bristles shorter (0.5 and 0.7 mm. long).

Ovipositor (Fig. 7).—Subanal plate broader than long, evenly setulose. Eighth tergum normal; sternum strongly modified, with a small median sclerite bearing a tuft of short setae and a pair of curved processes running caudad to enclose a cup-shaped depression on each side. Seventh segment short and broad; sternum broader than long, with scattered setulae on caudal half. Sixth segment somewhat reduced; sternum smaller than that of seventh and with a caudal emargination; tergum enclosing both sixth and seventh spiracles. Spermathecae two, spherical, with duct base scarcely swollen and almost prostrate along spermathecal surface.

Egg (Fig. 21)

Very similar to those of *Fannia* spp. particularly those of *F. canicularis* (L.)

and *F. scalaris* (Fab.). The shape is roughly ovate, the chorion laterally and ventrally unmarked except for a broad, faint ribbing. Subdorsally a pair of thin flaps extend the length of the egg, these being smooth externally with a raised pattern internally and enclosing a dorsal area marked with a raised hexagonal pattern.



Figs. 1-8

Figs. 1-2. Hypopygium and adjacent sclerites of *Euryonmma rettenmeyeri*: 1, postero-ventral view; 2, lateral view.

Fig. 3. Ventral view of ninth sternum of *E. rettenmeyeri*.

Figs. 4-5. Hypopygium and adjacent sclerites of *E. panamensis*: 4, posteroventral view; 5, lateral view.

Fig. 6. Ventral view of ninth sternum of *E. panamensis*.

Fig. 7. Ovipositor of *E. rettenmeyeri*, ventral view.

Fig. 8. Ovipositor of *E. panamensis*, ventral view.

Larvae and Puparium (Figs. 9-16)

Larva very similar to that of *F. canicularis*; only eleven visible segments; dorsoventrally flattened; a pair of dorsolateral and ventrolateral processes and a weak pair of dorsal processes on each abdominal segment, except for the terminal segment which is strongly flattened dorsally and bears three pairs of well-developed processes arranged radially around the posterior margin. Integument of mature larva and puparium finely pebbled. Anterior spiracles each with from six to eight radial processes; posterior spiracle on a distinct stalk and bearing three fingerlike processes arranged approximately at right angles to each other. Cephaloskeleton typical of the subfamily Fanniinae.

First Instar (Figs. 12, 14).—Length 1.5-2.4 mm. Integument dull whitish, sparsely covered with distinct spicules. Lateral processes apparent, not branched but covered with distinct spicules that are longer basad. Dorsal processes short but distinct and subequal. Posterior spiracular stalk enlarged basally, with a slender apex; only faint apical buds marking the long fingerlike processes of the later stages. Anterior spiracular processes short.

Second Instar (Figs. 11, 15).—Length 2.5-3.5 mm. Integument faintly pebbled along a network of lines. Lateral processes basally branched, the branches showing only faint apical forking. Dorsal processes short and rather smooth except on the penultimate segment, where they are three times as long as on preceding segments, distinctly spiculate, and weakly branched. Posterior spiracular stalk very short and broad, posterior and inner processes well developed, outer process present as a short bud. Anterior spiracular processes more evident.

Third Instar (Figs. 9, 10, 13, 16).—Length 3.6-6.0 mm. Integument straw-coloured, becoming medium reddish-brown and sculpturing more increasingly evident as the larva matures; the sculpturing appearing as irregular pebbling with a few scattered, flat, ovate plates. Lateral processes with distinct, furcate branches on basal third. Dorsal processes more distinctly branched than in second instar. Posterior spiracular stalk as long as or longer than wide; outer process distinctly developed, although shorter than other two. Anterior spiracular processes about three times as long as broad.

Puparium.—Length 5.5 mm. Integument dark reddish-brown, the sculpturing as in late third-instar larva. All other characters as in the mature larva, the reduced length a result of shrinkage of the integument and partial retraction of the thoracic segments.

Types

Holotype.—♂, Barro Colorado I., Canal Zone, Panama, 20.II.1956, No. 1208 (C. W. and M. E. Rettenmeyer). Ex *Eciton burchelli* refuse deposit, Colony E-107.

Figs. 9-21

Figs. 9-16. Larvae and puparium of *E. rettenmeyeri*. Figs. 9-11. Lateral views of larval cephaloskeletons: 9, third instar; 10, second instar; 11, first instar. Fig. 12. Dorsal view of mouth hooks of third-instar larva. Fig. 13. Ventral (left) and dorsal (right) views of cephalic segments of puparium. Figs. 14-16. Dorsal views of right halves of caudal segments of larvae (integumental pattern shown only for sixth segment): 14, first instar; 15, second instar; 16, third instar (ventral view figured on left side).

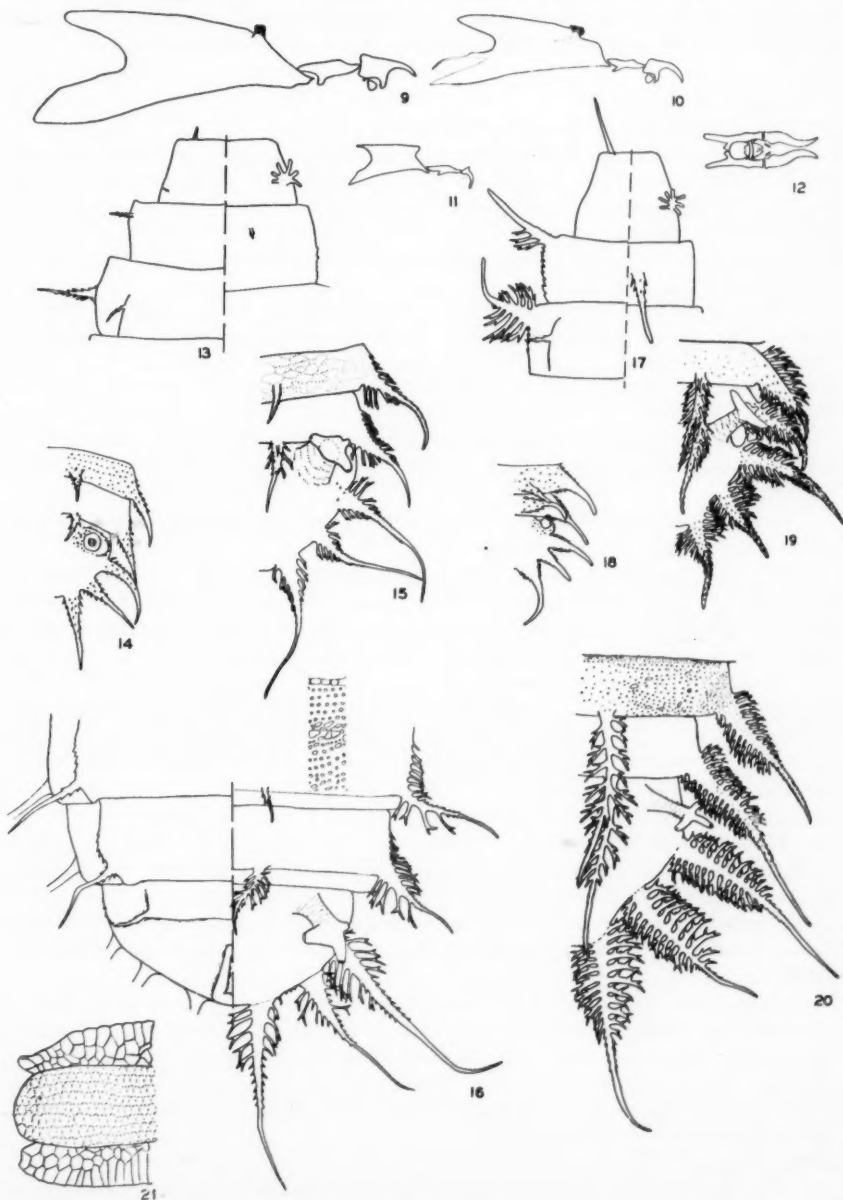
Figs. 17-20. Larvae of *E. panamensis*. Fig. 17. Ventral (left) and dorsal (right) views of cephalic segments of third-instar larva. Figs. 18-20. Dorsal views of right halves of caudal segments (integumental pattern shown only for sixth segment): 18, first instar; 19, second instar; 20, third instar.

Fig. 21. Dorsal view of anterior half of egg of *E. rettenmeyeri*.

Allotype.—♀, same locality and data, except: 23.V.1956, No. 1841, Colony E-156.

Paratypes.—7 ♂♂, same data as holotype; 23 ♂♂, 23 ♀♀, same data as allotype.

Additional Records.—3 ♂♂, 9 ♀♀, same locality, collection and association; 4 ♂♂, 19.II.1956, No. 1193, Colony E-107; 3 ♂♂, 16.VIII.1956, No. 2322,



Colony E-253; 26 ♂♂, 28.III.1956, No. 1580, Colony E-136 (Carl Rettenmeyer); 3 ♂♂, 2 ♀♀, 21.II.1955, No. 863, Colony '55 B-IV; 1 ♂, 28.II.1955, No. 916, Colony '55 B-IV; 1 ♂, 5 ♀♀, 23.II.1955, No. 890, Colony '55 B-IV; 2 ♂♂, 2 ♀♀, 9.III.1955, No. 991 (1 m. radius of bivouac), Colony '55 B-IV-S.

***Euryomma panamensis* n. sp.**

Figs. 4-6, 8, 17-20.

This species can be most easily recognized by the long-pubescent arista, the completely black palpi, and the infuscated basal antennal segments.

Male

Length 4.0 - 4.5 mm.

Differing from *rettenmeyeri* as follows:

Head.—Parafrontals slightly less than one-third as long as broad, less distinctly yellowish-pollinose, separated by a dark-brown frontal vitta twice as broad as either parafrontal. Basal antennal segment yellow tinged with fuscous; third segment black, one and three-fourths as long as broad; arista yellow on basal eighth, black apically, long-pubescent (hairs four times as long as basal arisal diameter). Palpus black.

Thorax.—Greyish-brown pollinose, with a narrow median vitta, a pair of narrow interrupted dorsocentral vittae, and a pair of diffuse lateral vittae medium brown. Acrostichals irregularly triserial throughout. Scutellum with basal marginal setulae reduced to one and the preapical discal bristles weak. Squamae subequal.

Abdomen.—1.0 by 1.8 mm. Dark grey-brown pollinose, the grey anterior markings more evident, extending medially to the more clearly outlined dorsocentral vitta.

Legs.—Hind tibia with one anteroventral, one anterodorsal; dorsal bristles shorter, the median 0.65 mm. long.

Hypopygium (Figs. 4-5). Cercal plate short and broad, no apical process. Surstylus partially fused with ninth tergum, narrow at base, then rapidly broadening to form a triangle. Ninth sternum rather slender, interrupted medially, with a long basal flange directed inwardly; postgonites reduced to small rods behind the aedeagus; aedeagus of equal breadth throughout, weakly curved dorsally. Fifth sternum completely divided medially, laterally produced into a slender process, bearing two apical and one preapical bristle; median portion with two or three strong and several weak bristles, caudal margin membranous, bearing a few short setulae.

Female

Head and Thorax.—As in the male.

Abdomen.—Markings more obscure than in the male, the grey evident only at lateral margins and on terminal segment.

Legs.—Mid femur as described for female of *rettenmeyeri*. Hind tibial dorsal bristles more nearly uniform, the preapical 0.45, the median 0.60 mm. long.

Ovipositor (Fig. 8).—Subanal plate slightly more triangular in shape than in *rettenmeyeri*, basal apodemes much broader. Eighth tergum somewhat broader; sternum of primitive form with two small submedian setose plates. Seventh segment as in *rettenmeyeri*, except slightly more setose. Sixth segment only slightly smaller and less setose than seventh, both spiracles enclosed in tergum. Spermathecae as in *rettenmeyeri*.

Larva (Figs. 17-20)

The larva of this species is rather distinct from that of *E. rettenmeyeri* and

resembles that of *Platycoenosia* Strobl in having well-developed, branched dorsal processes and elongate posterior spiracular stalks. It differs from both in that the branches of the processes are usually trifurcate, and much more numerous than in most other species of Fanniinae. The integument and anterior spiracular processes are similar to those of *E. rettenmeyer*i in the third instar, but in earlier instars the integument is virtually bare. The differences between the three stages of larvae, and between the larva and the puparium, are very similar to those in the preceding species. The mouth-hooks show no significant differences from those of *rettenmeyer*i.

Types

Holotype, ♂, and *Allotype*, ♀ (taken in copula and mounted on same pin).—Barro Colorado I., Canal Zone, Panama, 20.II.1956, No. 1208 (C. W. and M. E. Rettenmeyer). *Eciton burchelli* refuse deposit, Colony E-107.

Paratypes.—25 ♂♂, 4 ♀♀ as follows: 9 ♂♂, 2 ♀♀ same data as holotype; 3 ♂♂, 19.II.1956, No. 1193, Colony E-107; 1 ♂, 28.III.1956, No. 1580, Colony E-136; 1 ♂, 2 ♀♀, 23.V.1956, No. 1841, Colony E-156; 1 ♂, 15.V.1956, No. 1780 (from over swarm raid); (Carl Rettenmeyer) 2 ♂♂, 28.II.1955, No. 916, Colony '55 B-IV; 6 ♂♂, 23.II.1955, No. 890, Colony '55 B-IV; 3 ♂♂, 21.II.1955, No. 863, Colony '55 B-IV.

Summary

All stages of two new species of *Euryomma*, except for the egg and puparium of the rarer species, are described, no immature stages having been described previously for the genus. The two species were collected in both adult and immature stages in association with refuse deposits of colonies of army ants in Panama. The adults can be recognized from all other described species of *Euryomma* by the dark femora and tibiae.

(Received Sept. 22, 1958)

International Symposium Concerning the Problems of Ontogenetic Development of Insects with Special Attention to Methods of Experimental Work

On the occasion of the Second Czechoslovak Entomological Conference, arranged under the auspices of the Biological Section of the Czechoslovak Academy of Science and in collaboration with other institutions, an International Symposium concerning the problems of ontogenetic development of insects with special attention paid to the methods of experimental work will be held in Prague in the first half of September, 1959.

All applications for attendance and for lectures should be sent to the Secretariat of the Symposium, which will likewise supply all required information.

Address: Entomological Laboratory, Czechoslovak Academy of Science, 7, Vinicna, Prague 2, Czechoslovakia.

Invitations and a preliminary program will be sent in the first quarter of 1959.

Secretariat of the Symposium.

A Technique for Rearing the Red-Banded Leaf Roller, *Argyrotaenia velutinana* (Wlkr.) (Lepidoptera: Tortricidae), during the Winter¹

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The following method of rearing the red-banded leaf roller, a pest that has recently become increasingly destructive and difficult to control on apple in Ontario, was developed to obtain a supply of insects for insecticide tests during the winter. No reference to methods of rearing this insect in the winter were found in the literature. As the Field Station at Simcoe has no greenhouse or plant growth room, the entire procedure was conducted in an office room and basement except that some of the bean plants used were obtained from the greenhouse of the Entomology Laboratory, Vineland Station, Ont.

Mature larvae and the leaves in which they were webbed were collected in the fall from infested apple orchards, placed in 105-ounce cans covered with wire screen, and held at outdoor temperatures in the insectary. After pupation they were transferred in November to rearing cabinets at a constant temperature of 77°F. and a relative humidity of 64 per cent during the day and 70 per cent at night. Under these conditions adults emerged in seven days.

The moths were collected each morning and confined in groups of 50 or more in cylindrical wire-screen cages 4 inches in diameter and 7 inches high and lined on the inside with waxed paper. Water and food were supplied by moistening bits of absorbent cotton with water and a 10 per cent solution of molasses. The cages were placed near a window in the office room at a temperature of approximately 72°F. Egg laying took place readily and pieces of waxed paper bearing the egg masses were cut out and placed in covered petri dishes each containing one drop of water. They were held in a cabinet at 77°F., where the eggs hatched in five to six days.

The newly hatched larvae were transferred to the leaves of Scarlet Runner beans by jarring them off the dish or paper and allowing them to spin down on their webs onto the plants. Establishment mortality by this method was approximately 10 per cent. The plants, growing in 2-inch flower pots and kept to a height of 12 inches by nipping off the terminal buds, were enclosed in a box 3 feet x 6 feet and 18 inches deep that was covered with a sheet of transparent plastic. They were exposed continuously to the illumination from one 20-watt fluorescent lamp placed 18 inches above the tops of the plants. Approximately 100 plants were required to rear 400 larvae to maturity.

At room temperature (70° - 75°F.) the larvae reached maturity in 24 days and pupated on webbed leaves. The plants were examined daily and leaves containing pupae were clipped from the plants and placed in 105-ounce rearing cans each covered with insulating board in which a glass vial was inserted. The cans were held at room temperature near a window and the moths emerged in about 7 days and flew towards the light into the vials. They were then transferred to egg-laying cages.

Four generations of larvae were reared by this method from November to April with no occurrence of diapause or undue variations in development.

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²Assistant Entomologist and Assistant Technician.

Two New Black Flies from Saskatchewan (Diptera: Simuliidae)¹

By G. E. SHEWELL² AND F. J. H. FREDEEN³

The material on which the following descriptions are based was collected by the junior author during a study of the life-histories and ecologies of the Simuliidae of the Prairie Provinces. The type locality for both forms is the Shell River at the bridge on Provincial Highway No. 55, five miles west of Prince Albert and about 2½ miles above its junction with the North Saskatchewan River. Here the river is about 30 feet wide and has a bed of fine gravel or sand. When the collections were made, the water had a mean depth of one foot, a flow-rate of 1.5-2.0 ft. per second, and a temperature range of 55-59° F. Pupae were collected from emergent vegetation, chiefly grass blades, in the swifter parts of the stream. The following species were also taken at this site: *Simulium* (*Hellicbia*) *canonicolum* (D. & S.), *S. (Eusimulium) aureum* Fries, *S. (Byssodon) rugglesi* N. & M., *S. decorum* Wlk., *S. luggeri* N. & M., *S. tuberosum* Lund., *S. venustum* Say, and *S. (Neosimulium) vittatum* Zett.

Cnephia saskatchewanana n. sp.

Simulium sp. Twinn et al., 1948, Canadian J. Res., D, 26, p. 361.

Medium-sized, grey species. Thoracic dorsum of female trivittate, with rather sparse, short, white pubescence. Legs brown. Tarsal claw with blunt basal projection about half as long as the claw. Male holoptic. Length of body 2.5 mm., of wing 3.0 mm.

Female.—Head black, thickly grey-pollinose. Width of frons at vertex varying from less than one-fourth to almost one-third width of head; frons somewhat narrowed below, with rather short, sparse, decumbent white pile and, laterally, a few finer, more nearly erect, white hairs. Clypeus as broad as long, two to three times as broad as lower frons, with sparse, decumbent, white hairs. Occiput with long white pile and sparse, outstanding, black fringe. Antenna 11-segmented, black, microscopically white-pubescent, evenly tapered from enlarged second and third segments. Palpus black, white-pubescent, third segment much swollen. Mandible and maxilla with serrated margins.

Thorax black, grey-pollinose, disc brown-pollinose, pleural incisures and wing-root brownish. Mesonotum with three pale-grey vittae, median one narrow and straight, lateral ones broader and sinuous; mesonotal pile white, short, sparse, and decumbent, posteriorly longer, more nearly erect, and interspersed with black hairs. Pile of scutellum long, erect, white, with a few black hairs. Postnotum iridescent-pollinose. Pleural hair-tufts white; mesopleural membrane bare. Wing clear; veins pale brown; hairs of stem vein white; small basal cell present. Haltere pale brownish to almost white, base darker brown, hairs white. Legs dark brown; hairs white, on femora and tibiae mostly short and appressed; anterior femur, mid and hind tibiae, and hind metatarsus with sparse dorsal fringe of longer hairs; hind metatarsus 4½ to five times as long as wide, calcipala (Fig. 2) small, strongly tapered to almost pointed tip; second segment three times as long as wide, pedisulcus indistinct or absent; claw (Figs. 3, 4) with strong subbasal tooth which is slightly longer on that of middle leg.

Abdomen opaque dark grey; hairs, including basal fringe, white, longest and densest on pleura; intermediate tergites not much reduced. Genitalia as in Figs. 1, 1a. Anal lobe short, produced ventrad, posteroventral margin in-

¹Contribution No. 3842, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada, and No. 8, Canada Department of Agriculture Research Laboratory, Saskatoon, Saskatchewan; in part from a thesis submitted by Fredeen in partial fulfillment of the requirements for the degree of Master of Arts of the University of Saskatchewan.

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dented, outer surface strongly concave below; arm of genital fork robust, apex triangularly expanded, with thickened outer ridge, ovipositor lobes approximated, slightly divergent, slightly produced caudad.

Male.—Antenna 11-segmented, tapering from enlarged second and third segments to pointed tip. Hind metatarsus about four times as long as wide. Genitalia as in Figs. 5-7. Base of coxite with small inner apodeme; style broad, flattened dorsoventrally, about twice as long as wide, basal three-fourths straight, tip incurved, with minute subapical tooth; ventral plate moderately broad with strong, thickly haired ventral keel, basal arms convergent, slightly prolonged beyond their union with plate; paramere apically with dense cluster of long spines. (Described from a single reared specimen in poor condition).

Pupa.—Length of body 4.5 mm., of respiratory organ 1.5 mm. Latter (Fig. 9) with loose cluster of 17-19 slightly inflated, thin-walled filaments arising from bulbous base as follows: two ventral trunks each producing two (occasionally three) filaments; a stout lateral trunk producing seven filaments, three from its base, two at one-fourth its length, and a final bifurcation beyond middle; a stout dorsal trunk with variable branching producing seven or eight filaments, one much stouter than the others. Abdominal armature as in Fig. 8. First tergite with hairs only. Anterior spines of fifth to eighth tergites widely spaced, large, not interrupted middorsally. Terminal segment with or without two short, blunt spines and with lateral groups of minute, grapnel-shaped hooklets. Similar hooklets on ninth pleuron. Sternites weak. Cocoon boot-shaped, very loosely woven, with ragged, unstrengthened opening.

Larva (Figs. 10, 10a).—Length 7.0-8.0 mm. Head with diffuse light-brown markings. Gular cleft reaching to base of submentum, latter with an even row of 13 minute, blunt teeth. Antenna pale, first segment about half as long as second, latter subequal to third. Arms of X-sclerite broadly separated by central pale-pigmented area, anterior arm shorter than posterior.

Holotype, ♀.—Shell River, Prince Albert, Sask., May 12, 1949. H. Fredeen, lot 16403.105, spm. N7, reared. Adult pinned, genitalia on slide 5801-20A, pupal skin on slide 5702-14B. No. 6644 in Canadian National Collection, Ottawa.

Allotype, ♂.—North Saskatchewan River, Prince Albert, Sask., reared May 19 from larva collected May 13, 1954. Adult pinned, genitalia on slide 5801-20C, pupal skin on slide S231(b), legs and wing on slides S231(a)2 and (a)3.

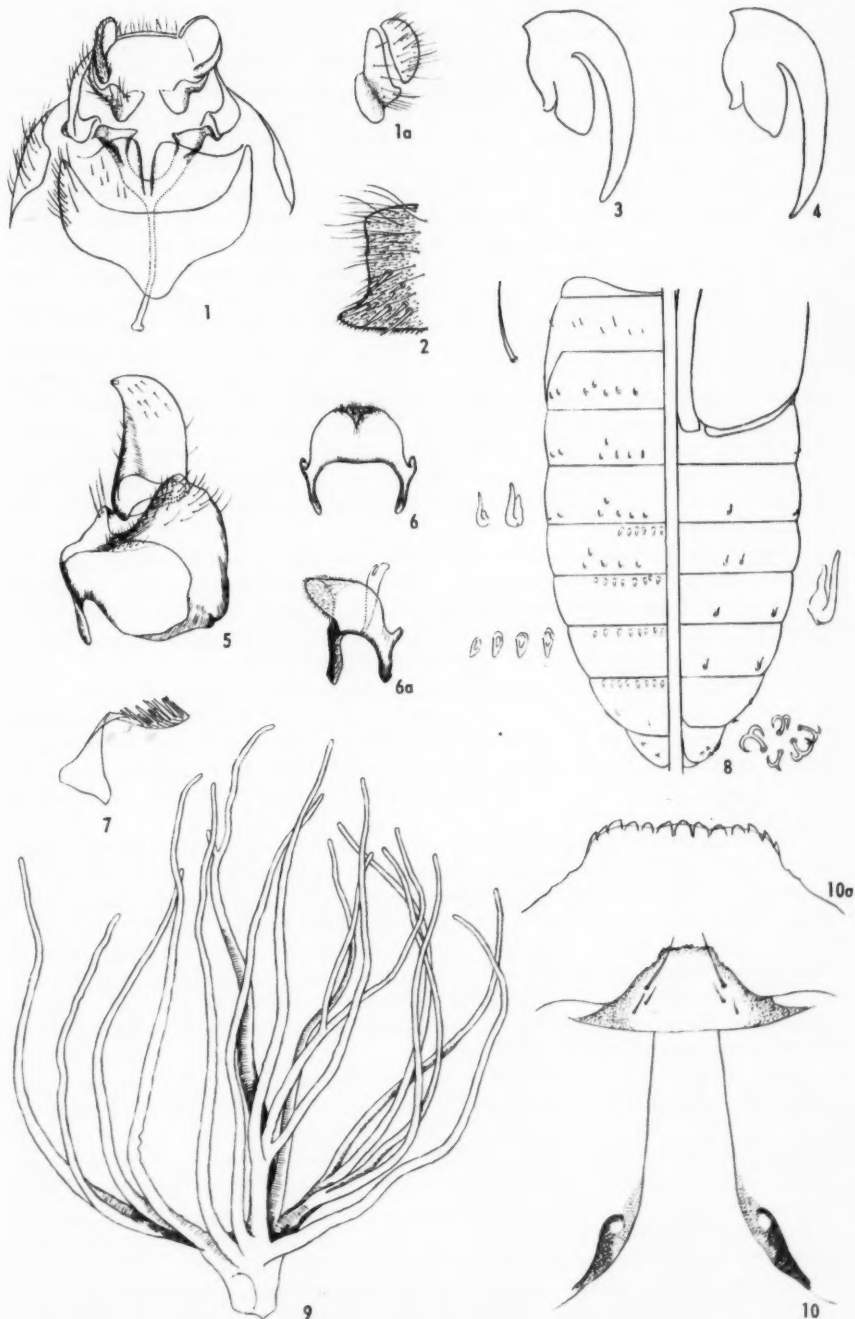
Paratypes, ♀.—Same data as holotype, spm. N8. 4 ♀ ♀, Shell River, May 26 and June 10, 1954, F. J. H. Fredeen, reared; two adults and two pupal skins on slides, remainder pinned.

Other Material.—Fragments of pupal skins and cocoons. Battle River, Prongue, Sask., May 20, 1953, Fredeen, on slides. Also the following material from Churchill, Man. Fragments of pupal skins and cocoons, Mosquito Pt., Churchill River, July 9, 1947, C. R. Twinn, on slides and in alcohol. 1 ♂ pupal skin, Warkworth Creek, June 20, 1951, L. R. Pickering, on slide. One pupa, three larvae, Goose Creek, July 1, 1953, R. Dunbar, on slides and in alcohol.

Simulium (Helichia) johannseni duplex n. subsp.

A small form. Female dark grey with whitish pubescence; thoracic dorsum

Figs. 1-10. *Cnephia saskatchewanana* n.sp. 1. Female terminalia, ventral. 1a. Left anal lobe and cercus, lateral. 2. Female; apex of hind tibia. 3. Female; claw of mid-tarsus. 4. Same of hind-tarsus. 5. Male; left coxite and style, inner surfaces. 6. Ventral plate, ventral view. 6a. Same, lateroventral view, with median sclerite attached. 7. Left paramere. 8. Abdomen of pupa; dorsal surface on left, ventral on right. 9. Left respiratory organ of pupa, lateral. 10. Head capsule of larva, ventral. 10a. Teeth of submentum of larva.



faintly trivittate; claw strongly bifid. Male holoptic, black, with darker, sometimes brownish, pubescence. Length of body 2.0-2.5 mm., of wing 2.5-3.0 mm.

Female.—Head dark grey, thickly pollinose. Frons at vertex about one-fourth as wide as head, half as broad as long, strongly narrowed below, with sparse, pale pubescence. Face about as broad as long, with pale hairs. Occiput with long, moderately dense, white pile; fringe confined to one or two black hairs near vertex. Antenna 11-segmented, dull black with microscopic white pile, robust, about equibroad on first eight segments, thence tapering to blunt apex. Palpus dull black with pale hairs, third segment not much swollen, fourth and fifth segments subequal. Mandible and maxilla with serrated margins.

Thorax thickly pollinose, brownish on disc, dark grey elsewhere; mesonotum with three narrow, inconspicuous, darker vittae; pile white, sparse, mostly short and decumbent, but long and erect to proclinate posteriorly and on scutellum; pleural hair-tufts white. Wing veins very pale; hairs, including those of stem-vein and basal section of radius, white; small basal cell present, sometimes indistinct. Haltere pale brownish-yellow, stalk darker, hairs white. Legs black, with grey pollen and white hairs; anterior metatarsus not strongly dilated; hind metatarsus six to seven times as long as wide, calcipala (Fig. 12) small, prominent; second hind tarsal segment about three times as long as wide, pedisulcus deep. Claw (Fig. 13) distinctly bifid, basal projection less than half as long as main tooth.

Abdomen dark grey, thickly pollinose; pile white, longest and densest on pleura; tergites three to six narrowed. Genitalia as in Fig. 11. Arms of genital fork stout, with broad, incurved flanges at middle; each arm with a strengthening ridge from middle to tip and another curving backward into the flange. Ovipositor lobes approximated, slightly divergent, short.

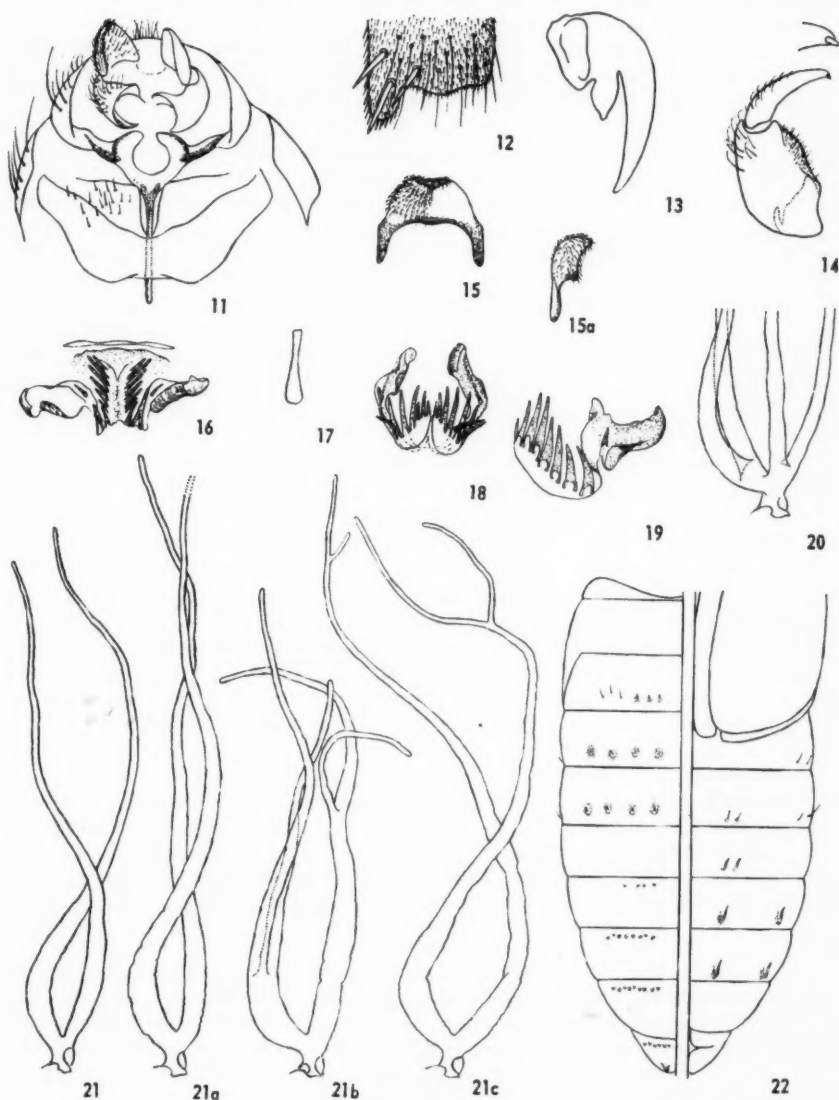
Male.—Uniformly dull greyish-black. Mesonotum in dorsal view matt black, in oblique view greyish, obscurely trivittate. Intermediate abdominal tergites black. Colour of hairs variable, mostly whitish to pale yellow, frequently reddish-brown on palpus, humerus, prescutellar area, base of stem-vein, bases of legs, and dorsum of abdomen. Hind metatarsus about 4.5 times as long as wide.

Genitalia (Figs. 14-17): coxite in ventral view two-thirds longer than broad, with a small basal apodeme on inner (dorsal) surface. Style four-fifths as long as coxite, slender, not flattened, moderately and evenly curved, and tapered to a blunt apex bearing a short subapical tooth. Ventral plate subarcuate, broadest across base, with stout basal arms, outer (ventral) surface moderately keeled, thickly clothed with recurved hairs. Median sclerite slender, tapering apically. Dorsal plate linear. Paramere oblong, constricted mesally; a small, recurved spine arising in membrane at base of arm, latter with a row of seven or eight long spines.

Pupa (Figs. 21, 22).—Length 4.0 mm. Respiratory organ 3.0-4.0 mm., usually two-filamented, without petiole at base; filaments moderately swollen, evenly tapering, sometimes either one or both filaments bifurcate at a variable distance from base. Abdominal armature as follows: second segment with one or two minute, recurved hooklets near middorsal line. Dorsal hooklets of third and fourth segments heavily pigmented at bases. One or more of ventral hooklets on segments four to seven sometimes bifid. Terminal hooks short, broad, and blunt, the tips slightly incurved.

Cocoon closely woven, slipper-shaped; aperture with reinforced rim.

Holotype, ♀, *Allotype*, ♂.—Shell River, Prince Albert, Sask., May 26, 1955, F. J. H. Fredeen, spms. 24 and 21, lots 140-142, reared, adults pinned,



Figs. 11-17, 21-22. *S. (Hellicbia) johannseni duplex* n.subsp. 11. Female terminalia, ventral. 12. Female; apex of hind tibia. 13. Female; tarsal claw. 14. Male; left coxite and style, outer surfaces. 15, 15a. Ventral plate, ventral and lateral views. 16. Dorsal plate and parameres. 17. Median sclerite. 21-21c. Right respiratory organ of pupa, lateral, showing variation. 22. Abdomen of pupa, dorsal surface on left, ventral on right.

Fig. 18. *S. (Hellicbia) johannseni* Hart, Havana, Ill. Male, parameres.

Figs. 19, 20. *S. (Hellicbia)* sp.?, Shell River, Sask. 19. Male; right paramere. 20. Base of right respiratory organ of pupa of same individual.

pupal skins on slides 5705-14B and -15A. No. 6645 in Canadian National Collection, Ottawa.

Paratypes, 6♂♂, 8♀♀.—Same data as types, spms. 15-31, individually reared. 10♂♂, 13♀♀, same locality, May 27 and June 2, 1950, and June 10, 1954, H. Fredeen, individually reared. 1♂, N. Saskatchewan River, Prince Albert, Sask., May 12, 1949, H. Fredeen, reared. Associated pupal skins and genitalic dissections from all lots mounted on slides.

Comments.—Typical *Simulium johannseni* Hart (1912) from central Illinois differs from the above form in having the pupal respiratory organ composed of four filaments, all arising at or close to the base, and in having the body vestiture of the male entirely white as in the female. Genitalic differences in either sex are hardly discernible, but in typical *johannseni* the parameral spines appear to be slightly longer and stronger (Fig. 18). A single reared male from the Shell River (Figs. 19, 20) is closer to typical *johannseni* in all the above characters, and suggests the possibility of the two forms being distinct species with overlapping ranges. However, because of inadequate material and scarcity of information on the distribution of either form, we think it best, provisionally, to give *duplex* the status of a subspecies.

Hellichia Enderlein (1925, type *Hellichia latifrons* End. from Norway) has affinities with both *Cnephia* End. and *Eusimulium* Roub. but it is more closely related to the latter. From *Cnephia* it differs in the adult by having a distinct though small calcipala and sometimes a well-developed pedisulcus, and in the male by the paramere having a single large spine isolated from the main cluster. The pupa differs in having no anchor-shaped or spirally twisted hooklets on either side of the tip of the abdomen, and in having a well-formed slipper-shaped cocoon, often with a dorsal process above the aperture. The larva has two prominent ventral papillae on the caudal segment. From *Eusimulium* the adult differs in wing venation, having usually a basal cell present, and the basal section of the radius longer in proportion to the total length of the wing. The male also differs in the structure of the paramere. The pupa does not differ significantly from *Eusimulium*, but the larva may be separated by its antenna, which is composed of seven to nine segments compared with four in *Eusimulium*. Besides *johannseni* Hart, the following North American species belong to *Hellichia*: *Eusimulium canonicolum* D. & S. 1927 (= *Simulium euryadminiculum* Davies, 1949, new synonymy), *S. (Eusimulium) baffinense* Twinn, 1936, and *S. (Eusimulium) subexcisum* Edw. (Twinn, 1936).

Summary

The adults and early stages of two new black flies, *Cnephia saskatchewanae* and *Simulium (Hellichia) johannseni duplex* are described and figured from specimens collected in Saskatchewan. The North American species of the subgenus *Hellichia* Enderlein 1925 are listed and one species is placed in synonymy.

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(Received August 15, 1958)

**A Report on Some North American Arctic and Subarctic
Ichneumoninae
First Supplement**

By GERD H. HEINRICH,
Dryden, Maine.

Coelichneumonops n. gen.

Type: *Coelichneumonops vockerothi* n.sp.

Female

In the areae dentiparae, which slope far downward, nearly extending to the base of coxae III, this genus resembles *Coelichneumonon* Thoms. The propodeal slope, however, does not curve downward abruptly as in the latter genus, but slants gradually down in an oblique plane.

Gastrocoeli quite different from those typical of the Protichneumonini: much shallower and rather small, considerably narrower than their interval.

Postpetiole not longitudinally striated, but finely and irregularly reticulated in one species, almost smooth and shining in the other. Horizontal part of propodeum densely reticulo-punctate, nearly opaque, costulae absent, areae superomedia and basalis not bordered by carinae, their place in one species indicated by a polished region.

Abdomen narrow, sharply oxygyous.

Male

Agrees in morphology of gastrocoeli and postpetiole with the female. Area superomedia more distinctly bordered behind. Scutellum more elevated. Tyloides very small in size and number, present on joints 7-14 or 15 of flagellum only, the longest occupying not more than about the middle third of the joint.

Coelichneumonops could almost be placed in the tribe Ichneumonini as well as in the Protichneumonini. For practical reasons I prefer the latter choice.

Colichneumonops vockerothi n.sp.

Holotype: ♀, Quebec, Great Whale River, 24.VII.1949, J. R. Vockeroth. Canadian National Collection No. 6779.

Allotype: ♂, Quebec, Fort Chimo, 24.VII.1948, E. H. N. Smith. (C.N.C.).

Paratypes: 3 ♀ ♀, Quebec, Great Whale River, 19.VII, 26.VII and 13.VIII.1949, J. R. Vockeroth; 1 ♂, New Hampshire, Mt. Washington, 17.VII.1929, G. S. Walley. (C.N.C.).

Female

Black, frontal orbits and orbits of the vertex yellow. Trochantelli, femora, tibiae and tarsi uniformly fulvous-red.

Length 10 mm.

Flagellum moderately attenuated towards the apex, flattened on one side and slightly widened beyond the middle; with 37 joints, the first joint twice as long as wide at the apex, about the 10th as wide as long, the widest seen from the flattened side about 1 1/2 times as wide as long, uniformly black.

Mandibles normal, the upper tooth longer than the lower.

Mesonotum and scutellum distinctly convex, shiny, strongly but not densely punctured, notaucles weakly indicated at the base.

Propodeum finely coriaceous-reticulate and punctured, opaque (except the metapleura which are shiny and not densely punctured). Horizontal part sloping down backwards gradually in an oblique plane reaching close to the base of coxae III. No trace of carinae bordering the area superomedia and area basalis.

Postpetiole rather broad with weakly indicated middle area, very finely and irregularly reticulate with some scattered punctures.

Gastrocoeli rather shallow, their outline nearly quadrangular, widened toward the outer border of the tergite, thyridia not smooth and shining, but very finely coriaceous-reticulate.

Abdomen narrow, strongly oxygygous, ovipositor a little projecting.

Male

Agrees in colour and morphology with the female, except that the sides of the clypeus and face are broadly yellow, the yellow areas at the sides of the face tapering gradually towards the level of the antennae. Orbits of vertex with a small yellow mark.

Flagellum entirely black with very small tyloides on joints 7-15 only. The tyloides are narrow and short-oval, the longest ones not occupying more than about the middle third of the joints. Scutellum much more raised than in the female. Bordering carinae of the area superomedia faintly indicated in the hind part.

In the single male from Mt. Washington the yellow markings of the head are reduced to the corners of the clypeus.

Coelichneumonops cashmani n.sp.

Holotype: ♀, Yukon Territory, Firth River, 69°30'N, 139°31'W, 17.VIII.56, E. F. Cashman. Canadian National Collection No. 6780.

Paratypes: ♀, from the same locality, 6.VIII.56, E. F. Cashman; ♀, Yukon Territory, British Mountains, 69°25'N, 139°45'W, 24.VII.56, R. E. Leech. (C.N.C.).

Female

Black without any other colour on head, thorax, abdomen, coxae, trochanters, and antennae.

Legs red, apex of tibiae III and tarsi III blackish-brown. Apical joints of tarsi I and II infuscated.

Length 10 mm.

Similar to *vockerothi*, but distinctly differentiated by:—

- 1) the shape of the gastrocoeli, which have a sharply triangular outline.
- 2) the polished and glossy sculpture of the region of the area superomedia and the postpetiole.
- 3) the shape of the temples and cheeks which are distinctly more strongly developed.

Morphology of flagellum almost as in *vockerothi*, except that the flattened joints are a little less widened.

Flagellum with 37 joints, the first twice as long as wide at the apex, the 10th as long as wide, the broadest joint seen from the flattened side only one-third wider than long.

Eutanyacra valdenigra n.sp.

Holotype: ♂, Quebec, Payne Bay, 60°01'N, 70°01'W, 11.VII.58, W. R. M. Mason. Canadian National Collection No. 6778.

As not many species of this genus are to be expected in the Arctic Region, and as the colour pattern of the type specimen is such that the association of the correct female cannot be expected to cause any trouble, I do not hesitate in this particular case to base the description of a new species on the male sex alone.

Male

Uniformly black, including head, thorax, abdomen, coxae, trochanters and antennae, except for a white vertical band on each side of the face, which is widened somewhat towards the clypeal foveae. Legs red, apex of tibiae III, apex of metatarsi III, and following joints of the tarsi III blackish.

Length 16 mm.

Flagellum with elongated-oval, relatively broad tyloides on joints 2-19, most of which reach both ends of the joints. Basal joint seen from below about 1 1/2 times as long as wide, so being relatively longer than in *E. chillcotti* Heinr., ♂, a character which certainly also applies to the as yet unknown female sex.

Scutellum highly and abruptly elevated above the level of the postscutellum.

Area superomedia transverse, more than twice as wide as long in the middle.

Hypopygial process well developed, distinctly longer than in *chillcotti*, gradually narrowing into the pointed tip.

Eutanyacra chillcotti Heinr.

Canadian Entomologist 88: 478. 1956.

Type Locality: Salmita Mines, Northwest Territories, Canada.

New record: ♀, Quebec, Payne Bay, 11.VIII.58, W. R. M. Mason. (C.N.C.).

The specimen from Payne Bay lacks the two short, white, longitudinal lines on the mesonotum present in the type-specimen, but otherwise agrees completely.

(Received November 13, 1958)

Eighth Annual Meeting, Entomological Society of Canada

The Entomological Society of Canada held its eighth annual meeting jointly with the ninety-fifth annual meeting of the Entomological Society of Ontario at the Ontario Agricultural College, Guelph, from October 29 to November 1. This was the first meeting of the national society at the headquarters of the Ontario society, which for many years served as a national society. A total of 172 members and friends attended, including 23 members and guests from the United States and 17 wives. At the beginning of the opening session, a minute's silence was observed in tribute to Dr. K. W. Neatby, Director, Science Service, Canada Department of Agriculture, who had died on October 27. Addresses of welcome were given by G. G. Dustan, President, Entomological Society of Ontario, Dr. J. D. MacLachlan, President, Ontario Agricultural College, and G. P. Holland, President, Entomological Society of Canada. At the opening session, Mr. Holland asked whether the Society was paying due attention to all its responsibilities. He considered that responsibilities to amateur entomologists might well be given more attention, possibly by providing a place for amateurs on the programs at annual meetings, by publishing handbooks, and by providing financial aid to students in entomology. He welcomed Dr. V. B. Wigglesworth, Cambridge University, England, to the meeting and also D. K. McE. Kevan, Head, Department of Entomology and Plant Pathology, Macdonald College, to Canada.

One invitation paper was presented, and symposia were held on trends in Canadian entomology, insect dispersal, and metabolism of insecticides, the last being sponsored jointly with the Agricultural Chemistry Subject Division of the Chemical Institute of Canada. Two sessions, each of two sections, were devoted to submitted papers.

On the evening of October 29, a smoker was held at the War Memorial Hall, Ontario Agricultural College. Mr. Holland gave a highly interesting, illustrated account of a trip with E. G. Munroe to New Guinea and other areas in the South Pacific for collecting insects, mainly pyralid moths and fleas.

On October 30, a cocktail hour and a banquet at the Royal Hotel were much enjoyed. Mr. Holland was chairman. W. A. Ross and A. W. Baker, the first and second presidents and leaders in the founding of the Society, reminisced on the early days of the Society. Certificates of honorary membership were presented to E. M. Walker, Professor Emeritus, University of Toronto, by H. H. J. Nesbitt and to E. M. DuPorte, Macdonald College, by M. L. Prebble. The guest speaker of the evening was Mr. Thor C. Hansen, Art Director, British American Oil Company, Toronto. In a provocative address on the arts and crafts in Canada, he stressed the importance of the use of the hands in mental health and happiness and as a foundation of all cultural activities. He was thanked by B. Hocking on behalf of the Society. A total of 179 members and friends attended the banquet.

Entertainment for wives included tours of the Home Economics Department of Macdonald Institute, the city of Guelph, a furniture store and showrooms, and the Physical Education Building and greenhouses, Ontario Agricultural College.

At the business session it was agreed that the subject of joining the Canadian Federation of Biological Societies be given special study during 1958-59, that the Executive Committee have the available information on the constitution of the Federation and other relevant matters assembled and distributed to all members of the Society, and that the directors representing the regional societies encourage study of the question, explain questions that arise, see that their societies form some opinion, and report to the Directors before the annual meeting in 1959.

Mr. Holland reported that the four volumes of the *Proceedings of the Tenth International Congress of Entomology* would be mailed by November 14 and that, though there would be little or no surplus, the finances of the Congress were satisfactory. It was agreed that the appreciation of the Board and the Society be extended to E. C. Becker for his highly satisfactory work as Secretary of the Editorial Committee for the *Proceedings*.

A report on behalf of W. R. Thompson, who was retiring as Editor, showed that the interval between receipt and publication of manuscripts was four to five months. Three supplements were on hand. It was agreed that a warm resolution of thanks be extended to Dr. Thompson for his services as Editor from 1947 to 1958. After considerable discussion about suggestions presented by H. H. J. Nesbitt concerning editorial policy for *The Canadian Entomologist*, it was agreed to recommend to the incoming board of directors that, in naming the new editor, it be made clear that he and the Editorial Board, in consultation with the Executive Committee, should have a free hand in formulating editorial policy and in printing *The Canadian Entomologist*. A vote showed that 60 favored having the identities of referees revealed to the authors at the discretion of the referees, that 16 favored having the referees remain anonymous, and that eight favored always having the names of the referees known to the authors.

B. M. McGugan provided copies of the audited financial statement for 1957, showing a deficit of \$555.40 for the period. W. S. McLeod provided copies of a financial statement for January 1 to October 15, indicating that receipts during the period exceeded disbursements by about \$2,700. These reports were adopted. It was agreed that the Executive Committee be authorized to defray expenses of travel and accommodation of such directors as necessary to ensure a quorum at

meetings of the Board, and also, as deemed necessary, expenses of appointed officers. The mailing list for *The Canadian Entomologist* on October 15 was made up as follows: regular members, 601; honorary and life members, 12; subscribers, 379; exchanges, 102; sustaining members, 5; total, 1,099.

The Secretary stated that the ballot for the election of officers for 1958-59 was mailed to members in good standing (513) on June 6. A total of 333 ballots were cast, the following being elected:—President-elect, 1958-59: B. Hocking; directors at large, 1958-60: J. L. Auclair, H. A. U. Monro; directors representing regional entomological societies, 1958-60: R. H. Burrage, A. G. McNally, C. A. Miller, P. Zuk. The following honorary members were elected on the mail ballot: E. M. DuPorte, E. H. Strickland, and W. R. Thompson. The first announcement of the annual meeting was mailed on June 20; the program was mailed on October 7. R. H. Wigmore having stated that he wished to retire as Secretary, A. W. Baker moved a hearty expression of appreciation to him for his services from 1950 to 1958.

E. J. LeRoux, Convener of the Membership Committee, reported that the Committee had solicited membership in the Society from entomologists who were employed in Science Service, Canada Department of Agriculture, and who had not previously joined the Society. Out of a total of 55, 15 had joined the Society and eight were considering membership for 1959. Dr. LeRoux reported the various reasons given by prospective members for not joining the Society. It was agreed that the application form for new members be abolished.

A report on behalf of A. V. Mitchener, Chairman of the Committee on Common Names of Insects, showed that six common names were proposed during 1958. Three of these were approved by the Committee and forwarded to Dr. H. H. Schwartz, chairman of the committee on common names of insects of the Entomological Society of America.

D. B. Waddell had submitted to the Directors a provisional list of minimum aids in presenting papers at annual meetings, on the basis of two sections for sessions for submitted papers.

After discussion concerning clarity of some items in the constitution, it was agreed that R. H. Wigmore and B. M. McGugan review the constitution concerning items that might be worded more clearly.

W. A. Fowler and W. G. Matthewman were elected as auditors for the 1958 accounts.

M. L. Prebble announced the personnel of the standing committees for 1958-59, as follows:—Nominating Committee: W. G. Friend (Convener), R. M. Prentice, A. S. West; Election Committee: E. C. Becker (Convener), B. M. McGugan, L. L. Reed; Membership Committee: E. J. LeRoux (Convener), J. J. Cartier, M. Hudon.

The annual meeting of the Society in 1959 will be held jointly with the Entomological Society of America and the Entomological Society of Ontario at Detroit from November 30 to December 3. Mr. R. H. Nelson, Executive Secretary, Entomological Society of America, and Dr. E. H. Smith, New York Agricultural Experiment Station, Geneva, chairman of the program committee for the American society for 1958-59, met with the Directors after the business session to co-ordinate planning for the joint meeting.

R. H. WIGMORE, *Secretary*

Three New Ontario Black Flies of the Genus *Prosimulium* (Diptera: Simuliidae)

Part II. Ecological Observations and Experiments¹

By DOUGLAS M. DAVIES² AND PAUL D. SYME³

Introduction

In an earlier paper (Syme and Davies, 1958), three new species in the *hirtipes*-complex (*Prosimulium fuscum* Syme and Davies, *P. mixtum* Syme and Davies and *P. fontanum* Syme and Davies) were described, compared with related species in other parts of the world, and their known distribution in northeastern North America indicated. In this paper are presented observations on the manner and dates of oviposition, on incubation, on the larval feeding, on the rate of larval growth during the fall and winter in a spring-fed stream, and on differences in habitat and seasonal emergence of the three new species.

Oviposition and Incubation

A number of simuliid species are known to be univoltine and in many of these the eggs are in diapause throughout the late spring and summer and in some even throughout the fall and winter as well. Females of *fuscum* and *mixtum* lay eggs in May and June. In the discussion of oviposition by Davies and Peterson (1956), the specimens referred to as *P. hirtipes* (Fries) have now been identified as a combination of *fuscum* and *mixtum* in equal numbers. The proportion of *fuscum* was greater at the end of May 1956 when collections of ovipositing flies were begun whereas *mixtum* increased in proportion thereafter and was collected without *fuscum* after June 6. The females of these two species dispersed their eggs freely in the water while flying (Davies and Peterson 1956, pp. 636-7). Two groups of eggs, laid in moistened glass vials by these flies, were kept for one and two months respectively, but no larvae hatched up to August 6. It appears from studies made near Palgrave, Ontario, discussed later, that eggs hatch in the fall after a diapause through the warm season. The method of oviposition allows the eggs to disperse and settle into crevices on the bottom where they are more likely to remain moist if the water level of the stream drops appreciably during the summer as it often does.

Larval Feeding

Larvae of *fuscum* and *mixtum* strain food particles from the water in the same manner as described for other species by Peterson (1956), and analyses of contents of the alimentary tracts of larvae collected from a stream near Palgrave revealed a variety of algal species, especially diatoms and desmids. In the laboratory, the larvae of both species fed on filamentous algae from the substrate and one appeared to have devoured half a small naïd worm. Sand grains and other detritus also were found in their alimentary tracts. They appeared to be mainly herbivorous, but fed occasionally on animal material.

Several experiments were performed to determine the rate of ingestion of food by larvae of *fuscum* and *mixtum*. Larvae were starved from 4 to 14 days until their alimentary tracts were empty and then were placed in 1/16 inch of water in petri dishes with filamentous algae, sometimes with a little detritus as well. At temperatures of 40-50°F. one-quarter to half the larvae had half-filled their tracts in 5-8 hours and had completely filled them by 20-26 hours whereas other larvae had their tracts only 1/4-1/3 filled by this time. Even

¹Contribution from the Department of Biology, McMaster University, Hamilton, Ontario, supported by grants from the National Research Council of Canada.

²Associate Professor of Zoology, McMaster University, recipient of Summer Research Associateships of the National Research Council in 1956 and 1957.

³Graduate student, McMaster University, recipient of a Department of Biology Scholarship in 1956-7, now at University of Toronto.

TABLE I

Time taken by 62 larvae of *P. fuscum* and *P. mixtum* to void full alimentary tracts in $\frac{1}{4}$ " clear water in a petri dish at 40-50° F.

Time in days	% alive	% empty	% $\frac{1}{4}$ - $\frac{1}{2}$ full	% $\frac{1}{2}$ - $\frac{3}{4}$ full
0	100	0	0	0
8	81	34	50	16
16	39	61	25	14
23	14.5	-	-	-
33	2	-	-	-

at 35°F. in standing water some larvae with empty tracts were able to fill them in 24 hours by feeding on filamentous algae. Larvae of *fuscum* and *mixtum* were kept alive in shallow water at 35-45°F. for six weeks, some pupating even at 35°F.

An experiment was conducted to find how long it took these larvae to void their alimentary tracts of food material. Sixty-two larvae of *fuscum* and *mixtum* which had been kept in a jar with algae and detritus for 9 days were placed under $\frac{1}{4}$ inch of clean tap water in a petri dish at a temperature between 40-50°F. The water was replaced periodically and excreta removed. It is seen from Table I that most larvae took a week to half-empty their tracts and over two weeks to clear them completely.

The larvae appear to be able to fill their tracts within a day or two and this meal may not be fully digested for two weeks. This may have considerable survival value.

Rate of Larval Growth

The rate of growth of larvae in a spring-fed stream in the upper Humber river drainage system near Palgrave, Ontario, was studied from November, 1946, to mid-April, 1947. Larvae were collected periodically at a site in an open cedar-poplar wood where the stream was 2-3 ft. in width and its bank and bed were mainly grass-covered. The temperatures of the air and water were measured at each collection date, the latter checked several times by a maximum-minimum thermometer left in the stream. Fifty to one hundred feet above the site the stream flowed through a number of small permanent springs which made the stream more stenothermal below, so that during the fall and winter of 1946-47 this section of the stream was maintained at a temperature of $41 \pm 6^\circ\text{F}$. Paradoxically, whenever the air temperature rose above 32°F . the water temperature fell because of melting snow.

Information on the seasonal change in the supply of planktonic food for the larvae was obtained by supercentrifuging (at 38,500 r.p.m.) 10 litres of stream water collected periodically, and by counting, on a haemocytometer slide, the number of algae in at least five samples from 250 c.c. of the concentrated suspension. During the fall and winter the number of algae varied from 260-830 per c.c. of stream water, 80% or more of which was diatoms and desmids. The samples contained varying amounts of inorganic silt particles and organic detritus as well.

Adults reared from this part of the stream in the spring of 1946 and 1947 revealed that the population comprised about 20% *fuscum*, 78% *mixtum* and 2% *Cnephia* (*Mallochianella*) *mutata* Meigen.

The study of larval growth was begun by measuring the head-capsule length and the total volume of fifty or more larvae collected periodically from the stream. The two species were treated as one because in 1947 *P. birtipes* (s.l.) was not considered to be a complex. To measure volume, fifty larvae were blotted dry and their displacement of "ice" water in a 1 cc. syringe, calibrated to 0.01 c.c., was noted. These measurements were plotted against the date (Fig. 1). Collections were begun a few weeks after most larvae had hatched. Although a few were still hatching on November 7, 1946, the main

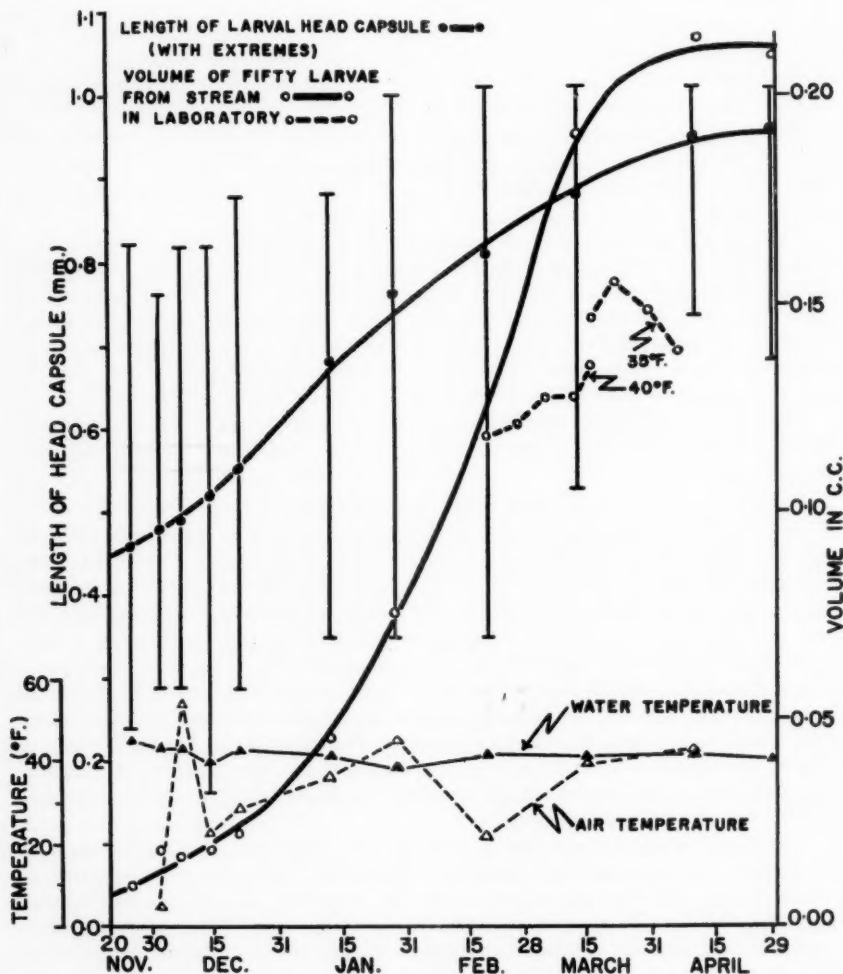


Fig. 1. Growth of larvae of *P. fuscum* (20%) and *P. mixtum* (78%) from November, 1946, to April, 1947, in a spring-fed stream near Palgrave, Ontario. Growth was measured each time both by volume and by the length of head capsule in 50 randomly selected larvae. Larvae collected from the stream were grown in standing water with filamentous algae for comparison with growth in the natural habitat.

hatch occurred probably in late September or early October, as judged by the extrapolation of the growth curves (Fig. 1). The curves for volume and head-capsule length both indicate a typical 'S' shape. Growth in volume of fifty larvae was at a maximum of about 0.0025 c.c. per day from mid-January to mid-March and the total change in volume for fifty larvae during the 150 days from hatching to pupation averaged 0.21 c.c. The final volume on April 24, 1947, was the measure of 25 larvae and 25 pupae, because they were equally numerous in the stream at this date. The head-capsule length varied from 0.16 mm. in newly hatched larvae of the first instar to 1.1 mm. in mature larvae before pupation. The extremes of head-capsule measurements on each collection date (Fig. 1) reflect that larval hatching occupied several weeks and that the rate of growth of individual larvae differed. No relation was apparent between rate of growth and the temperature, the rate of flow of the water or the amount of suspended plankton in the water, but only the rate of flow showed any progressive change with time. It increased from 2 to 3 ft. per sec. during the fall and winter as the level of the water increased.

The total day-degrees above 32°F. during the larval development of *fuscum* and *mixtum*, from the main hatch on about October 1 (as judged by extrapolation) to halfway through pupation on April 24 (as judged by last stage larvae and pupae being in equal numbers), was 2000 at an average temperature of about 41°F. This compares with 500 day-degrees above 32°F. for *Simulium*

TABLE II
Summary of Data From Emergence Collections

	Emergence	<i>fuscum</i>	<i>mixtum</i>	<i>fontanum</i>	Average water temperature
Hopkin's Ck. 1957	First Date Median Date Last Date	— April 29? May 7?	April 25? April 26? May 5?		57°F. (No last stage <i>fuscum</i> and <i>mixtum</i> larvae on May 3)
	% of population	63	37		
Smith's Ck. 1947	First Date Median Date Last Date % of population	May 12 May 21 May 31 57	May 17 May 20 May 31 43		52°F.
Costello Ck. 1940	First Date Median Date Last Date % of population	May 12 May 16 May 31 73	May 13 May 21 May 31 27		55°F.
Smith's L. Inlet 1946	First Date Median Date	— —	— May 16?	May 25 June 3	52°F. (<i>fontanum</i> emergence 54°F.)
	Last Date % of population	May 24 33?	May 29* 33?	June 11 33?	
L. Sasajewun Tote Rd. Stream 1955	First Date Median Date Last Date % of population			June 20? — August 8 100?	52°F.

*One female June 4.

venustum Say during May, 1947, in Costello creek, Algonquin Park, at an average temperature of about 48°F. (Davies, 1950).

Two other sites upstream from the first site and less influenced by springs, thus less conservative in temperature, were examined less regularly. In these the larvae were a little larger in November but pupation occurred after April 9, the date that pupation was first observed at the first site. This may have been because during the winter the parts of the stream not moderated by springs were observed to reach a low of 32.1°F. whereas at the first site the minimum water temperature recorded was 35.5°F.

Larvae collected from the stream were maintained in the laboratory at 35°F. and 40°F. in shallow standing water with filamentous algae. These grew less rapidly than those in the natural habitat (Fig. 1). This may have been in part the result of the larvae having to scrape food from the substrate rather than filter feeding.

Habitat Preference

In order to determine differences in habitat preference of the three species, a number of streams were sampled, mainly in the area enclosed by the Hamilton, Owen Sound, Algonquin Park, Haliburton and Toronto regions (Tables III-V), although two streams near Chalk River were also sampled.

P. fuscum and *mixtum* were frequently found in the same stream together, but only seldom were all three found breeding in one stream. A number of streams harboured only one of the species. Although *fuscum* and *mixtum* overlapped broadly in their requirements of habitat, *fuscum* inhabited larger more rapid streams, such as those draining medium-sized lakes on the Precambrian Shield, where *mixtum* was usually absent. On the other hand, *mixtum* inhabited streams of much slower current where *fuscum* was not found. Both these species, however, inhabited smaller streams or creeks of moderate current, and in such streams were usually found together although usually *fuscum* was more numerous. *P. fontanum* differed markedly in its breeding site, inhabiting small streams that originated from a bog or spring, usually in wooded country.

The water temperatures of a number of streams across Ontario were measured in 1940, 1946, 1947, 1956 and 1957 during the pupation of these species. The average temperature for ten streams inhabited by *fuscum* from April 9 to June 7 was 52.7°F. (38-67°F.), for ten inhabited by *mixtum* from April 9 to June 5 it was 55.2°F. (38-68°F.), and for seven inhabited by *fontanum* from May 5 to August 4 it was 53.5°F. (45.5-63°F.). When *mixtum* was pupating and emerging at Inglis Falls on June 23, 1956, the water temperature was 48°F., and if we average this with the temperatures from the other streams, the average temperature for *mixtum* becomes 54.6°F. The population of *mixtum* at Inglis Falls was shown to differ morphologically from the typical *mixtum*, showing some features more similar to *fontanum* (Syme and Davies 1958). Its breeding in a stenothermal, cool stream in summer is also more typical of *fontanum*. Except for this case, however, it appeared that the streams frequented by *mixtum* were of slightly higher temperature, as well as of slower velocity, than those frequented by *fuscum*.

Although during the pupal period of the black flies the average water temperature was roughly similar for many of the streams inhabited by each of the three species, the time of year that black flies pupated and emerged differed markedly in the case of *fontanum*. This emphasizes that streams having an average water temperature of about 55°F. in April and May but becoming much warmer during June and July are unsuitable for the slowly-developing

TABLE III
Distribution of *P. fuscum*

Date	Locality	Form collected	Data from
III- 6-57	Caledon Trout Club near Inglewood, Peel Co., Ont.	Last instar larvae	PDS
III-10-57	Caledon Trout Club	Mature larvae	PDS
III-21-57	Caledon Trout Club	Mature larvae	PDS
III-24-55	Rattlesnake Pt., Nelson Twp., Halton Co., Ont.	Mature larvae	KR
III-24-57	Kahshe R. at No. 11 Hwy., Ont.	Mature larvae	PDS
III-26-57	Kahshe R. at No. 11 Hwy., Ont.	Mature larvae	PDS
III-31-57	Marsh's Falls, Algonquin Pk., Ont.	Mature larvae	KR
III-31-57	Park Headquarters, Algonquin Pk., Ont.	Mature larvae	KR
III-31-57	Collingwood, Ont. (Idle's Stream)	Mature larvae	KR
III-IV-56	Stream crossing No. 17 Hwy., 4 mi. w. of Deep R., Ont.	Mature larvae	KR
IV- 1-56	Caledon Trout Club	Pupae	PDS
IV- 8-56	Caledon Trout Club	Pupae	PDS
IV-10-36	Yonkers, N.Y.	Adult	CNC
IV-10-49	Lake Sasajewun dam, Algonquin Pk., Ont.	Mature larvae	DMD
IV-17-53	Bell's Corners, Ottawa, Ont.	Mature larvae	CNC
IV-21-24-57	Long Lake (Eaton Pond Outlet), Adirondacks, N.Y.	Mature larvae	KR
IV-27-57	Kahshe R. at No. 11 Hwy., Ont.	Pupae	PDS
IV-29-52	Marmora, Ont.	Adult	CNC
IV-30-56	Lake Sasajewun Outlet, Algonquin Pk., Ont.	Pupae	PDS
V-1-7-57	Hopkin's Ck., Dundas, Ont.	Adult ♀	CNC
V- 3-49	Lake Sasajewun dam, Algonquin Pk., Ont.	Adult	PDS
V- 3-44	Kingston, N.S.	Adult	DMD
V- 5-53	Knowlton, P.Q.	Adult	DMD
V- 5-57	Lyon's Inlet, Ancaster, Ont.	Adult ♂	CNC
V- 6-51	Gatineau Pk., Eardley, P.Q.	Adult	PDS
V- 6-51	Beech Grove, P.Q.	Adult	CNC

TABLE III (continued)
Distribution of *P. fuscum*

Date	Locality	Form collected	Data from
V- 7-56	Hopkin's Ck., Dundas, Ont.	Pupae	PDS
V- 8-56	Lower Buttermilk Falls, Hamilton, Ont.	Mature larvae	PDS
V- 8-56	Lyon's Inlet, Ancaster, Ont.	Pupae	PDS
V- 11-57	Bala, Ont.	Adult	DMD
V- 12-56	Kalshe R. at No. 11 Hwy., Ont.	Exuviae	PDS
V- 13-50	Blanch R. Powerhouse, P.Q.	Adult	CNC
V- 15-28	Hemmingford, P.Q.	Adult	CNC
V- 16-50	Ashton, Ont.	Adult	CNC
V- 17-26	Ithaca, N.Y.	Adult	CNC
V- 18-56	Walker's Line, Halton Co., Ont.	Adult	CNC
V- 20-23	Tetreauval, P.Q.	Mature larva	PDS
V- 23-33	Wakefield, P.Q.	Adult	CNC
V- 24-23	Kentville, N.S.	Adult	CNC
V- 24-32	Meach Lake, P.Q.	Adult	CNC
V- 26-27	Miner's Bay, Ont.	Adult	CNC
VI- 3-37	Lac Cavament, P.Q.	Adult	CNC
VI- 5-55	Str. N25, Buisson, Baie Comeau, P.Q.	Adult	CNC
VI- 12-55	Dry Creek, Baie Comeau, P.Q.	Adult	CNC
VI- 16-48	Goose Bay, Labrador	Adult	CNC
VII- 28-50	Goose Bay, Labrador	Larvae	CNC
VIII- 2-34	Gaspe Co., P.Q.	Adult	CNC
IX- 6-50	Goose Bay, Labrador	Larvae	CNC

CNC = Canadian National Collection, Ottawa.

KR = Dr. K. Rothfels, University of Toronto

DMD = Dr. D. M. Davies, McMaster University

PDS = P. D. Syme.

TABLE IV
Distribution of *P. mixtum*

Date	Locality	Form collected	Data from
III-21-57	Terra Cotta, Ont. (Credit System)	Mature larvae	KR
III-24-55	Rattlesnake Pt., Nelson Twp., Halton Co., Ont.	Mature larvae	KR
III-27-46	Palgrave, Ont.	Pupae	DMD
III-IV-56	Collingwood, Ont. (Ide's Stream)	Mature larvae	KR
III-IV-57	Stream crossing No. 17 Hwy., 4 mi. w. of Deep R., Ont.	Mature larvae	KR
IV-6-57	Inglewood, Ont. (Credit System)	Mature larvae	KR
IV-7-57	Rattlesnake Pt., Nelson Twp., Halton Co., Ont.	Mature larvae	KR
IV-15-57	Collingwood, Ont. (Ide's Stream)	Mature larvae	KR
IV-17-53	Bell's Corners, Ottawa, Ont.	Mature larvae	KR
IV-21-24-56 and 57	Long Lake (Eaton Pond Outlet), Adirondacks, N.Y.	Mature larvae	KR
IV-21-47	Palgrave, Ont.	Pupae	DMD
IV-25-V-5-57	Hopkin's Ck., Dundas, Ont.	Adult	PDS
IV-26-56	Terra Cotta, Ont. (Credit System)	Mature larvae	PDS
V-1-56	Terra Cotta, Ont. (Credit System)	Pupae	KR
V-3-53	Site F, Knowlton, P.Q.	Larvae	CNC
V-3-44	Kingston, N.S.	Adult	DMD
V-3-4-53	Knowlton, P.Q.	Larvae, Adult	CNC
V-4-53	Site A, Knowlton, P.Q.	Adult	CNC
V-5-56	Terra Cotta, Ont. (Credit System)	Pupae	PDS
V-7-53	Stn. L, Mississquoi R., Bolton, P.Q.	Larvae, pupae, adult	CNC
V-7-56	Hopkin's Ck., Dundas, Ont.	Pupae	PDS
V-8-35	Cayuta L., N.Y.	Adult	CNC
V-8-56	Mineral Springs, Ancaster, Ont.	Pupae, exuviae	PDS
V-8-56	Lyons Inlet, Ancaster, Ont.	Pupae	PDS
V-8-43	Bagotville, P.Q.	Larvae	DMD
V-11-57	Bala, Ont.	Adult	DMD
V-12-56	3+ mi. w. of Uphill, Victoria Co., Ont.	Pupae, adults	PDS
V-14-22	Kingsmere, P.Q.	Adult	CNC

TABLE IV (continued)
Distribution of *P. mixtum*

Date	Locality	Form collected	Data from
V-14-44	Portugal Cove Rd., St. Johns, Nfld.	Larvae	CNC
V-18-56	Rattlesnake Pt., Nelson Twp., Halton Co., Ont.	Pupae	PDS
V-20-35	Hull, P.Q.	Adult	CNC
V-20-27-54	Corbett Brook, Fredericton, N.B.	Larvae	CNC
V-22-49	Black Ash Ck., Collingwood Twp., Ont.	Adult	CNC
V-23-35	Hull, P.Q.	Adult	CNC
V-28-56	Rattlesnake Pt., Nelson Twp., Halton Co., Ont.	Pupae, exuviae	PDS
VI-56 and 57	Bear Ck., N.Y.	Mature larvae	KR
VI-14-55	Smith Lake, Baie Comeau, P.Q.	Adult	CNC
VI-18-52	Stanhope, P.E.I.	Adult	CNC
VI-21-31	Gatineau Hills, P.Q.	Adult	CNC
VI-23-56	Inglis Falls Inlet (Owen Sound, Ont.)	Pupae, adults	PDS
VI-25-49	Goose Bay, Labrador	Adult	CNC
VII-6-55	Manic Depot, Baie Comeau, P.Q.	Adult	CNC
VII-10-42	Ungava Barrrens, P.Q. (Lat. 56°57'3", Long. 71°0.4')	Adult	CNC
VII-14-48	Knob Lake, P.Q. (Lat. 54°47', Long. 66°47')	Adult	CNC
VII-19-55	Manicouagan R., Baie Comeau, P.Q.	Adult	CNC
VII-24-49	Great Whale R., P.Q.	Adult	CNC
VII-26-33	Gaspé, P.Q.	Adult	CNC
VII-29-48	Ft. Chimo, P.Q.	Adult	CNC
VII-VIII-56	Terra Cotta and district, Ont.	Adult	CNC
IX-16-32	Grand Cascapedia, P.Q.	Mature larvae	KR
		Adult	CNC

CNC = Canadian National Collection, Ottawa.

KR = Dr. K. Rothfels, University of Toronto.

DMD = Dr. D. M. Davies, McMaster University.

PDS = P. D. Syme.

TABLE V
Distribution of *P. fontanum*

Date	Locality	Form collected	Data from
IV-23-58	L. Sasajewun Tote Rd., Stream No. 1, Algonquin Pk., Ont.	Mature larvae	DMD
V-18-53	Site L, Knowlton, P.Q.	Larvae	CNC
V-21-53	Sutton Mts., East Hill, P.Q.	Larvae	CNC
V-22-53	Site O, Knowlton, P.Q.	Larvae	CNC
V-25-46	Smith's L. Inlet, Algonquin Pk., Ont.	Adults	DMD
VI-1-57	Fox Point Inn, Lake of Bays, Ont.	Mature larvae	KR
VI-2-57	N. Star Lodge, Chalk R., Ont.	Mature larvae	KR
VI-2-57	Fox Point P.O., Lake of Bays, Ont.	Mature larvae	KR
VI-17-57	Streams in Petawawa Forest Reserve, Ont.	Mature larvae	KR
VI-17-57	L. Sasajewun Tote Rd., Stream No. 1, Algonquin Pk., Ont.	Larvae	PDS
VI-17-57	L. Sasajewun Tote Rd., Stream No. 2, Algonquin Pk., Ont.	Larvae and pupae	PDS
VI-18-57	Bate's Ck., L. Opeongo, Algonquin Pk., Ont.	Mature larvae	PDS
VI-18-57	Ck. opp. Fish Lab., L. Opeongo, Algonquin Pk., Ont.	Pupae	PDS
VI-20-56	L. Sasajewun Tote Rd., Stream No. 1, Algonquin Pk., Ont.	Mature larvae	PDS
VI-21-56	L. Sasajewun Tote Rd., Stream No. 2, Algonquin Pk., Ont.	Pupae	PDS
VI-21-56	Bate's Ck., L. Opeongo, Algonquin Pk., Ont.	Pupae	PDS
VI-21-56	Ck. opp. Fish Lab., L. Opeongo, Algonquin Pk., Ont.	Pupae	PDS
VI-21-56	Brewer L. S. Inlet, Algonquin Pk., Ont.	Mature larvae	PDS
VI-22-56	N. Star Lodge, Chalk R., Ont.	Pupae	PDS
VI-22-56	Laurentian Pt., Chalk R., Ont.	Mature larvae	PDS
VI-22-56	L. Sasajewun Tote Rd., Stream No. 1, Algonquin Pk., Ont.	Pupae	PDS
VI-30-41	Smith's L. Inlet, Algonquin Pk., Ont.	Mature larvae	DMD
VII-25-55	Manicouagan R., Bate Comeau, P.Q.	Adult	CNC
VIII-8-56	L. Sasajewun Tote Rd., Stream No. 1, Algonquin Pk., Ont.	Pupae, exuviae, adults	DMD

CNC = Canadian National Collection, Ottawa.

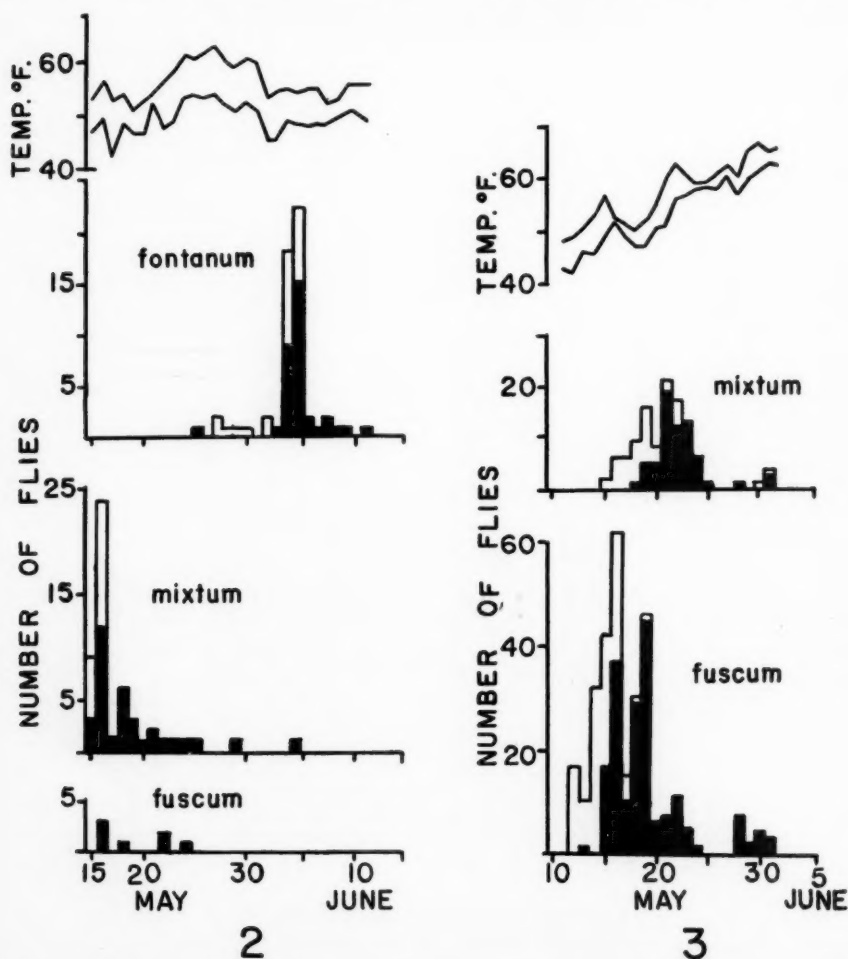
KR = Dr. K. Rothfels, University of Toronto.

DMD = Dr. D. M. Davies, McMaster University.

PDS = P. D. Syme.

fontanum. Only streams that retain a temperature of about 50-60° F. until July or August appear to be suitable for this species. The distribution of *fontanum* (Syme and Davies 1958) may be related to this, because cool bog-fed streams are characteristic of the granite portion of Ontario.

The larvae of all three species were found on rocks and vegetation. However, *P. fuscum* larvae occurred in higher numbers and more often on rocks in larger streams of swifter current than the other two. This species pupates in masses on rocks, the rather extensive cocoons often adhering to form a silken mat that binds the pupae together. *P. mixtum* larvae, on the other hand, were usually more scattered and were more often on vegetation. They pupated singly, although sometimes quite thickly, in vegetation, and never in large groups on rocks. *P. fontanum* larvae were also usually quite scattered and



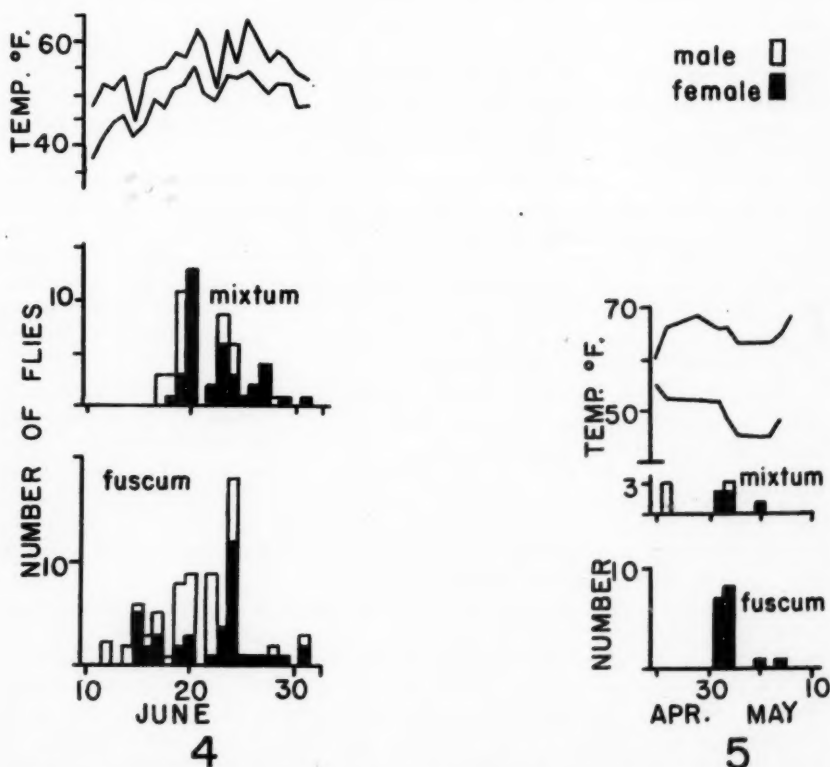
Figs. 2, 3. Daily emergence of both sexes of *Prosimulium* adults from a square yard of different Ontario streams and the maximum and minimum water temperatures. Fig. 2. Smith's lake inlet in 1946. Fig. 3. Costello creek, just below Costello lake, in 1940.

pupated singly in the vegetation (often in *Fontinalis* moss). Their cocoons consisted of only a few strands of silk and sometimes pupae were lying naked in the sand at the bottom of minute pools.

It may be that the amount of cocoon built by each species is related to the type of stream inhabited. Thus, *P. fuscum* with the heaviest cocoon of the three is more exposed to abrasive action of particles and to being torn from its support in the larger, faster-flowing streams, which it inhabits. *P. mixtum*, which inhabits streams of the slower velocity, also constructs weaker cocoons, while *P. fontanum*, which usually inhabits small streams of even slower current, constructs the least cocoon of all. This relation does not hold in every case because of the variety of streams inhabited by each species, but in general there does appear to be a relation between the type of stream inhabited and the amount of cocoon built.

Seasonal Emergence of Adults

Certain streams were selected in which two, or all three, of the species were developing at the same time, so that differences in the seasonal emergence of adults could be determined. Cubic yard screen cages, developed by Ide (1940), were placed over the stream bottom and the emerging flies collected periodically, usually daily.



Figs. 4, 5. Daily emergence of both sexes of *Prosimulium* adults from a square yard of different Ontario streams and the maximum and minimum water temperatures. Fig. 4. Smith's creek in 1947. Fig. 5. Hopkin's creek in 1957.

Collections from Hopkin's creek at the York Road, Dundas, in 1957, and from two streams in Algonquin Park in 1940 and 1947 showed a mixed population of *fuscum* and *mixtum*. A comparison of the seasonal emergence of each sex of these two species together with the maximum and minimum temperatures between each collection is shown in Figs. 2-5.

In Hopkin's creek the population of *Prosimulium* was low, probably because of early flooding, and repeated disturbance of the cage by vandals decreased markedly the value of the results. The collecting of only females of *fuscum* (Fig. 5) suggests that collections were begun after the male emergence although previous searches for pupae had been unsuccessful, mainly because of the small population. It is considered that the emergence period of *mixtum* was covered, however.

Larger collections of *fuscum* and *mixtum* were obtained in 1940 from Costello creek (Fig. 3), originally discussed by Davies (1950) under the name *P. birtipes* (s.l.), and in 1947 from Smith's creek* (Fig. 4). From these collections a good picture was obtained of what had already been suspected from earlier field work by the authors and others. *P. fuscum* emerged a few days earlier than *mixtum*, and the males of both species preceded the females by a few days.

A third collection made by the senior author in 1946 from a bog-fed stream, Smith's Lake inlet, also in Algonquin Park, proved to have all three species present so that the emergence of *fontanum* could be compared with the other two species, all developing under the same conditions (Fig. 2). Again the emergence of *mixtum*, although overlapping that of *fuscum*, was a little later. However, *fontanum* emerged later than either *fuscum* or *mixtum*, with little overlapping. The male emergence of *fontanum* was a few days earlier than that of the females as in the other two species.

The data from various observations on emergence is summarized in Table II. In each instance the dates of first and last emergence and the date when 50% of the emergence was completed (median date) is given, along with the average water temperature during the emergence span and the relative abundance of each species in the *Prosimulium* population. This emphasizes again that where the two species existed together *fuscum* usually began to emerge a day or two ahead of *mixtum*, and where *fontanum* was present as well it was by far the latest to begin and end emergence.

In each instance, except in Hopkin's creek in southern Ontario, the average water temperature during the emergence span was about 52° F. (Table II). When this temperature is greater (e.g., Costello creek, 1940) there is a lesser difference between the dates of first emergence of *fuscum* and *mixtum*. Both these species develop faster at higher temperatures, as indicated by the collection from Hopkin's creek, and consequently in southern Ontario, where the streams warm up more quickly in the spring, both *fuscum* and *mixtum* emerged half a month earlier than in Algonquin Park.

It is probable that the eggs of *fontanum* hatch in the fall because mature larvae were found on April 23, 1958, the water temperature being 35° F. If they hatch in the fall, then the larvae develop more slowly than those of *fuscum* and *mixtum* as judged by the emergence collections from Smith's Lake inlet in 1946. *P. fontanum* will be most successful in cool streams that retain temperatures of about 60° F. or less into late June or even early August. In Tote Road stream No. 1, which flowed into Lake Sasajewan, Algonquin Park and whose temperature rose only from 50-54.5° F. from June 20-August 4, emerg-

*The head-capsule lengths of 15 larvae, of the same population as that collected emerging, averaged 0.54 (0.37-0.58) mm. on November 28, 1946 at a water temperature of 32.5° F.

ence was prolonged into August but in Smith's Lake inlet, where water temperatures rose to 60-63° F. for a week beginning on May 24, the emergence of *fontanum* was completed before mid-June.

From the numerous collections from across northeastern Canada and New York State (Tables III to V) it seems that 87% of the records of pupae and adults of *fuscum* occurred between April 1 and June 5. However, the large larvae on July 28 and September 6 and the adult on August 2 are difficult to explain. One explanation is an exceedingly attenuated emergence in a cool stream, or another is that all or a portion of the eggs did not enter a diapause and produced a second generation. Eighty per cent of the records of *mixtum* pupae and adults occurred from March 27 to June 25. The mature larvae found in July and August and the adults found throughout July and on September 16, may indicate an attenuated single annual generation or a second generation. This was shown also by the collections of mature *mixtum* larvae by Rothfels (pers. commun. 1957) in March and April and again in July and August, 1956, in streams near Terra Cotta, Ontario. However, there was no evidence of a second generation in *fuscum* or *mixtum* in Costello creek, Algonquin Park in 1940 (Davies, 1950). Ninety per cent of the records of *fontanum* pupae and adults occurred from April 23 to June 30 but the records of pupae and adults to August 8 indicate an attenuated generation as discussed previously.

Feeding of Adults and Ovarian Development

Examination of newly emerged adult females of all three species indicated small fat bodies and eggs little developed. The female mouthparts of all three species were well developed for piercing, averaging about 28 (24-31) teeth on the maxillae and 47 (43-54) on the mandibles with little difference between species. Both *fuscum* and *mixtum* have been observed sucking blood from humans, and *fontanum* at least crawling on them. It appears, therefore, that all three species require blood to complete the development of the eggs in the ovaries. But reared *hirtipes* (s.l.) matured eggs without blood (Wu 1931).

Discussion

In an earlier paper (Syme and Davies, 1958) morphological and distributional differences among the new species *Prosimulium fuscum*, *P. mixtum* and *P. fontanum* were seen to substantiate the cytological separation of the three species. Further support for the distinctness of these species was provided by the ecological evidence gathered during the study. *P. fontanum* stands out uniquely since its habitat and span of adult emergence differ markedly from those of the other two species. The cool, small spring-fed or bog-fed streams inhabited by this species differ from most of the streams harbouring *fuscum* and *mixtum* in that they remain cool for most of the summer. It is possible, however, that any of these streams could harbour *mixtum* and even *fuscum* in the early spring as indicated in the collection from Smith's Lake inlet in 1946 (Table II). Also, Rothfels (pers. comm., 1958) has evidence of early emergence of *mixtum* in several of the *fontanum* streams, which he examined in Ontario.

Temperature appeared to be one of the most important factors determining whether these species would be present or absent in a certain stream and if present at what stage of development they would be on a certain date. As most of the medium to large streams in South and Central Ontario warm up considerably in the summer, the main emergence of at least *fuscum* and *mixtum* occurs in the spring, although all stages can be found throughout the spring and summer if a variety of streams is sampled. This may indicate a wide range in length of diapause in eggs, thus in their hatching dates, and in rates of

growth among larvae of each of these species. Eggs of *fuscum* and *mixtum* are known to be laid singly into the water and presumably settle into crevices on the stream bed. It is possible that some *fuscum* and *mixtum* eggs do not hatch in the fall because they are covered with silt but hatch the following spring when vernal floods expose them, initiating hatching.

Although Rubtsov (1939) mentioned that the threshold of larval development for simuliids living in cold water was about 37.4° F., larvae of *fuscum* and *mixtum* fed and even pupated at 35° F. Radzivilovskaya (1950) said that the minimum temperature for the appearance of *P. hirtipes* in streams is 38.7 to 41° F., but *fuscum* and *mixtum* were found in Ontario streams at temperatures as low as 32.1° F. Some of the larvae of *fuscum* and *mixtum* in the stream near Palgrave lived during the winter under a cover of ice and snow, and various amounts of frazzle ice were present in certain parts. The abundance of larvae declined throughout the winter, especially in stretches away from the moderating influence of springs. Rubtsov (1939) found simuliid larvae to be incapable of surviving in streams that were frozen to the bottom. Larvae of *Simulium costatum* Fried. did not survive in a block of ice but lived for a long time under a cover of ice (Grenier, 1945), which is similar to observations on chironomid larvae (Leonard, 1939). Grenier found that the population, although dense initially, decreased gradually during the winter.

The majority of the individuals of *fuscum* and *mixtum* overwinter as larvae and this agrees with the observations on *P. hirtipes* (s.l.) in North America (Stone and Jamnback, 1955; Sommerman *et al.*, 1955). The regular growth of larvae of *fuscum* and *mixtum* throughout the winter reported in this paper is probably only characteristic of streams that, because of inflowing springs, maintain a moderate temperature compared to the surrounding air temperature. It is likely that rate of larval growth would be more depressed in mid-winter in those streams more influenced by the air temperature, and would rapidly accelerate in the spring.

This study has provided data on the ecology and behaviour of *fuscum*, *mixtum* and *fontanum*. Thus *fontanum* can be distinguished clearly from the other two by its cool, stenothermal, aquatic habitat and its attenuated later emergence, just as it could be by cytological and morphological features. On the other hand, *fuscum* and *mixtum* even in their habitat preference are similar and, as in most of their morphological features, overlap broadly in their ecological and phenological peculiarities. But the fact that these two species overlap in these peculiarities again substantiates, rather than refutes, their distinctness.

Summary

1. *P. fuscum* and *P. mixtum* females deposited eggs freely into the water while flying.
2. Eggs of *fuscum* and *mixtum* were in diapause during late spring and summer, and those of *fontanum* at least that long.
3. Larvae of *fuscum* and *mixtum* although usually filter feeding on planktonic algae, could fill their alimentary tracts with filamentous algae in less than 24 hours, but took over two weeks to void their tracts again.
4. Larvae of *fuscum* and *mixtum* took from fall until early spring, almost seven months, to develop at a temperature of $41 \pm 6^\circ \text{F.}$, requiring 2000 day-degrees above 32° F., during this period. The increase in volume per larva from hatching to maturity was about 0.0042 c.c.

5. Larvae of *fuscum* and *mixtum* were found in streams at temperatures as low as 32.1° F., and fed and pupated in the laboratory at 35° F.

6. Streams inhabited by *fuscum* were larger and swifter than those frequented by *mixtum*, and many drained medium sized lakes. Most of the streams containing these two species warmed up rapidly in the spring making conditions unsuitable for *fontanum*, which bred in stenothermal spring-fed or bog-fed streams maintaining a temperature between 50-60° F. at least into July and even August or later.

7. Emergence of *fuscum* and *mixtum* overlapped, that of *fuscum* beginning and reaching a maximum a few days earlier. Adults of *fontanum* began to emerge after all but a few adults of *mixtum* had emerged. The collection of some adults of each species in mid and late summer may indicate a second generation or an attenuated first generation.

8. All three species attack humans and appear to require a blood meal for ovarian development.

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(Received May 29, 1958)

A Simplified Clip Cage for Aphid Investigations¹

By M. D. NOBLE²

At the Vancouver laboratory a large number of cages were needed to confine aphids to single leaves in virus transmission experiments. The cages had to be of simple construction, light, and easily manipulated. The cage developed was similar to that of MacGillivray and Anderson (1957), but was simpler to make, and the materials were easily obtained locally. The materials are: acrylic plastic tubing, metal hair-curl clips, foam rubber, corks to fit the tubing, and muslin.

The body of the cage (Fig. 1) is 5/8 in. high and the plastic ring at the

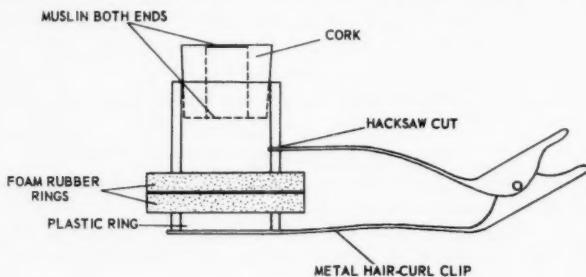


Fig. 1

base 1/8 in. high. These are cut with a hacksaw from the plastic tubing (3/4 in. x 1/16 in., outside diameter; Granville Plastics Ltd., 356 West 2nd Ave., Vancouver). Foam-rubber rings with a 5/8 in. opening are cut from a sheet 1/8 in. thick (Foam Rubber Centre, 1690 West 6th Ave., Vancouver), with a 5/8-in. cork borer. The clip is a 3-inch-long hair-curl clip (Lady Mervin Do-All Clips, Mervin Wave Clip Co. Inc., Buffalo, N.Y.) with its upper prong shortened by 1 in. and its lower prong by 1/4 in.

The plastic ring is glued to the top of the lower prong, and the body of the cage is slotted with a hacksaw 3/16 in. from the bottom to receive the upper prong. The slot is just long enough to allow the prong to be forced into it. To anchor the upper prong in the slot, plastic cement (Granville Plastics), which dries clear, is the best adhesive tested. A hole about 5/16 in. in diameter is cut in the cork and fine muslin glued over the ends. Pliobond (Goodyear Tire & Rubber Co., Toronto) is the best adhesive tested for gluing the foam rubber rings to the plastic, the muslin to the cork, and the lower prong of the clip to the plastic ring. Six feet of tubing and two square feet of foam rubber are enough to make 72 cages.

The foam-rubber rings are best left with an overlap of 3/16 in. to 1/4 in. A pair of narrow-nosed pliers is used to adjust the arch of the prongs to attain an even contact between the pieces of foam rubber.

In use the cage has proved very satisfactory; it is quickly applied, is easily filled with aphids of restless species, and leaves a minimum of damage after it has been on the leaf for a week.

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(Received Aug. 15, 1958)

THE RUNGE PRESS LIMITED, OTTAWA
Mailed: Wednesday, December 31, 1958

